SCHOOL OF CIVIL ENGINEERING

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JOINT HIGHWAY RESEARCH PROJECT

JHRP-76-21

ENGINEERING SOILS MAP OF PUTNAM COUNTY, INDIANA

P. T. Yeh

purdue university

PURDUE UNIVERSITY

INDIANA STATE HIGHWAY COMMISSION

Final Report

ENGINEERING SOILS MAP OF PUTNAM COUNTY, INDIANA

TO:	J. F. McLaughlin, Director Joint Highway Research Project	June 23, 1976
		File: 1-5-2-58
FROM:	H. L. Michael, Associate Director Joint Highway Research Project	Project: C-36-51B

The attached report, entitled "Engineering Soils Map of Putnam County, Indiana", completes a portion of the project concerned with development of county engineering soils map of the state of Indiana. This is the 58th report in the series. The report was prepared by Dr. P. T. Yeh, Research Engineer, Joint Highway Research Project.

The soils mapping of Putnam County was done primarily by airphoto interpretation. Some test data along Interstate 70 are included in the report. Generalized soil profiles of the major soil for each land form are presented on the engineering soils map. An ozalid print of the Engineering Soils Map of Putnam County is included in the report.

Respectfully submitted,

Harold L. Michael

Harold L. Michael
Associate Director

HLM/ss

cc:	W. L. Dolch	M. L. Hayes	C. F. Scholer
	R. L. Eskew	K. R. Hoover	M. B. Scott
	G. D. Gibson	G. A. Leonards	K. C. Sinha
	W. H. Goetz	C. W. Lovell	L. E. Wood
	M. J. Gutzwiller	R. D. Miles	E. J. Yoder
	G. K. Hallock	P. L. Owens	S. R. Yoder
	D. E. Hancher	G. T. Satterly	

Final Report

ENGINEERING SOILS MAP OF PUTNAM COUNTY

by

P. T. Yeh
Research Engineer

Joint Highway Research Project

Project No.: C-36-51B

File No.: 1-5-2-58

Prepared as part of an investigation

conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

In cooperation with

Indiana State Highway Commission

Purdue University
West Lafayette, Indiana

June 23, 1976

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance given by all those persons who have helped in the preparation of the report. Special acknowledgements are due the members of the Advisory Board, Joint Highway Research Project, for their active interest in furthering the study: Professor R. D. Miles, in charge of the Airphoto Interpretation, Photogrammetry and Site Selection Laboratory for review and suggestions and Mr. Mac H. Robards, Area Soil Scientist, Soil Conservation Service, United State Department of Agriculture for his effort in furnishing valuable soil information for Putnam County.

All airphotos used in connection with the preparation of this report automatically carried the following credit line: Photographed for Commodity Stabilization Service, Performance and Aerial Photography Division, United States, Department of Agriculture.

ENGINEERING SOILS MAP
OF
PUTNAM COUNTY, INDIANA

INTRODUCTION

The engineering soils map of Putnam County, Indiana which accompanies this report was done primarily by airphoto interpretation. The aerial photographs, having an approximate scale of 1:20,000, were taken in August 1939 for the United States Department of Agriculture and were purchased from that agency.

Aerial photographic interpretation of the land forms and engineering soils of this county was accomplished in accordance with accepted principles of observation and inference (1)*. A field trip was made to the area for the purposes of resolving ambiguous details and correlating aerial photographic patterns with soils texture. Standard symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, were employed to delineate land forms and soil textures. The text of this report largely represent an effort to overcome the limitation imposed by adherence to a standard symbolism and map presentation.

Although no soil samples were collected and tested by the staff of the Joint Highway Research Project, general soil profiles were developed and are shown on the soils map. The soil profiles were compiled from the agriculture literature and from the boring data of the roadway soil survey along I-70 supplied by the State Highway Commission. Liberal reference was made to the "Formation Distribution and Engineering Characteristic of Soils" (2), "Soil Survey of Putnam County, Indiana (3).

*Numbers in parentheses indicate reference in the bibliography.

DESCRIPTION OF AREA

General

Putnam County is located in the midwestern part of the state. It is about 50 miles (48.3 Km) west of Indianapolis. The county is rectangular in shape except for a narrow irregular offset in the southeastern corner. The county is bounded on the east by Hendricks and Morgan Counties, on the north by Montgomery County, on the west by Parke and Clay Counties and on the south by Clay and Owens Counties (Figure 1). The length from north to south is about 27 miles (43.5 km) and the greatest distance east and west is about 20 miles (32.2 km). The included area of Putnam County is approximately 488 square miles (1,264 sq. km) or 312,320 acres (1,263,959,000 sq. meters) (4).

Greencastle located nearly at the center of the county is the largest city and the seat of the government of Putnam County. The city had a population of 8,852 while the county held a total number of inhabitants of 26,932 as reported in the 1970 Census (5).

According to the 1964 Census of Agriculture 81.7% of Putnam County or 255,228 acres (1,032,908,000 sq. m.) was farm land (4). There were 58,417 acres (236,414,000 sq. m) of wooded land in the county which was generally confined along the bluffs and gullies of rivers and streams as shown in Figure 2.

Drainage Features

The northwestern part of Putnam County drained southwesterly by Big Raccoon Creek is included in the Wabash river basin. The

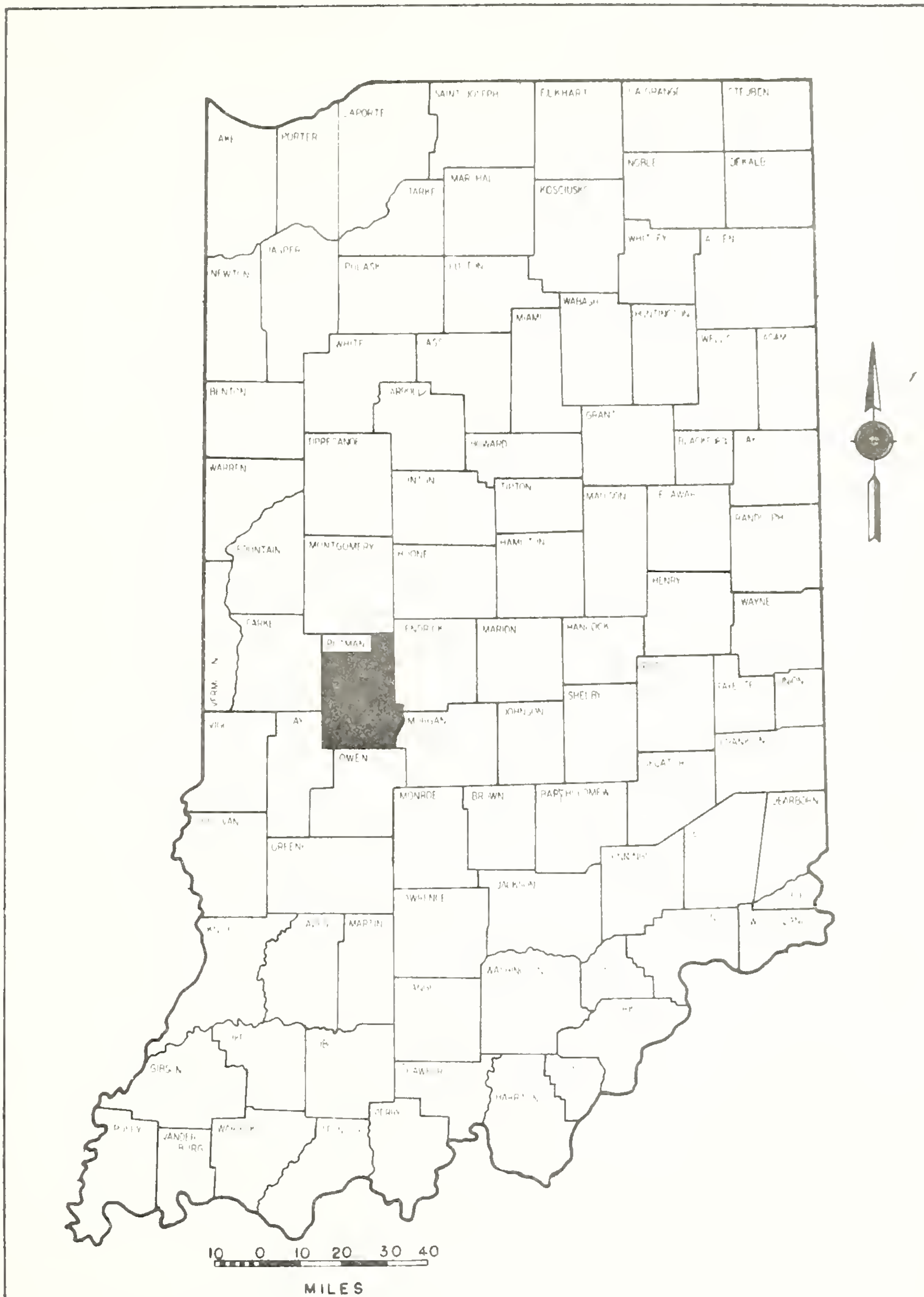


FIG. I LOCATION MAP OF PUTNAM CO.

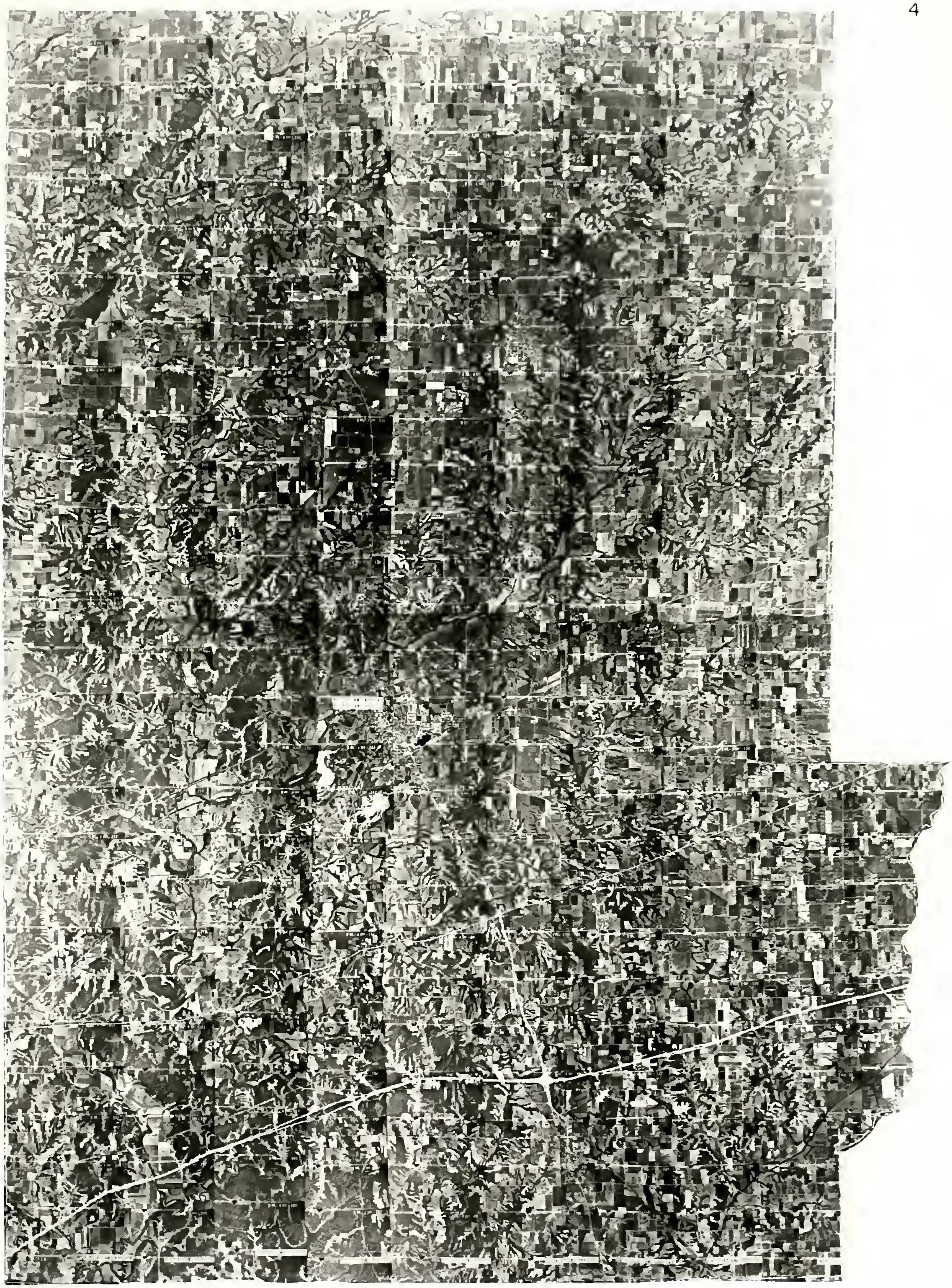


FIG. 2. AIRPHOTO MOSAIC OF PUTNAM COUNTY, INDIANA

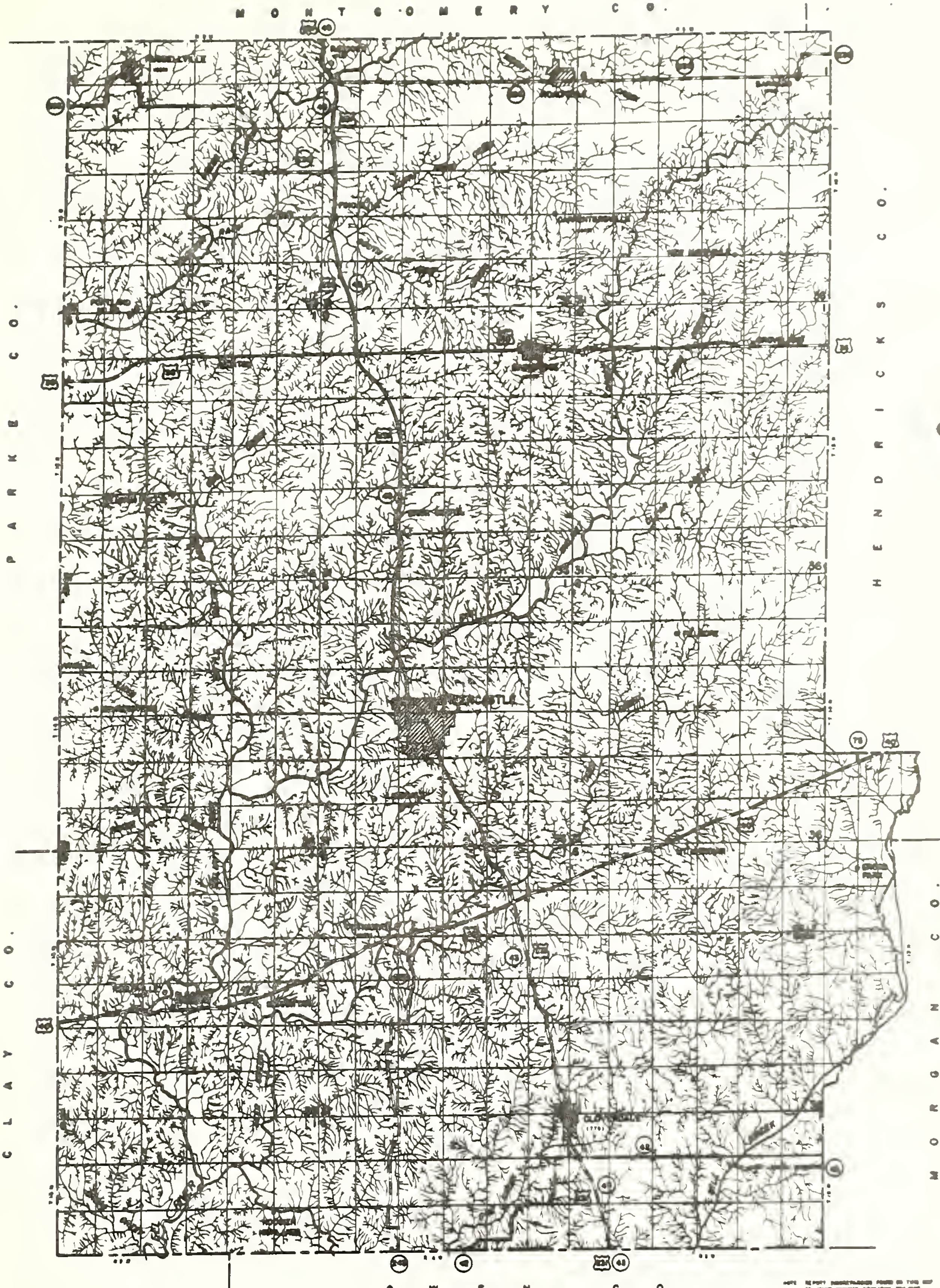
FROM 1967 INDEX MAP

rest of the county belongs to the White River basin which is a subbasin of the Wabash River system.

Henry Creek and Ramp Creek are the tributaries of the Big Raccoon Creek in the northern part of Putnam County. The major drainage channel in Putnam County is the Big Walnut Creek which travels diagonally across the county from the northeastern corner to the southwestern portion. Little Walnut Creek is the major tributary from the north while Plum Creek and Clear Creek are the smaller tributaries from the east. Big Walnut Creek empties into Eel River at the confluence with Mill Creek at a point about one and one half miles (2.4 km) north of the southern county border (See figure 3). The southeastern part of Putnam County is drained by Mill Creek which serves as the southeastern border marker of the county. Mill Creek has a rather unusual course. It flows in a southwesterly direction into Owen County than changes to a westerly course in that county and finally to a northwesterly direction and reenters into Putnam County where it joins with Deer Creek, its major tributary, and then shifts into a southwesterly course again before discharging into Eel River.

Rock control of the drainage ways is most obvious in the courses of Big Walnut, Little Walnut, Deer Creeks and along the Big Raccoon Creek (See Figure 3). Drainage lines are controlled to a large extent by the underlying rock strata especially in the western quarter of the county.

Ditches have been constructed and streams channels have been dredged and straightened to facilitate the flow of waters in the southeastern corner of the county along Mill Creek where the topography is extremely flat. There are no large natural lakes



DRAINAGE MAP

PUTNAM COUNTY

FIG. 3

in the county. Cagle Mill Reservoir near the southern border and Heritage Lake near the eastern border are large man-made lakes in Putnam County. There are many smaller ponds and lakes of various origins scattered throughout the county. Most are the result of limestone quarry and gravel pit operation.

Climate

The climate of Putnam County is continental, humid and temperate, with hot summer and cold winters. The mean annual precipitation is 42.21 inches (107 cm) at Greencastle. The summary of temperature and precipitation and the extremes data in the following two pages was compiled by the U. S. Department of Commerce, weather bureau, in cooperation with Purdue Agricultural Experiment Station (6).

Phsiography

More than half of Putnam County lies within the Tipton Till plain physiographic region of the state. The southwestern portion, however, is in three physiographic regions. Progressively from the east to the west they are: the Michell Plain, the Crawford Upland and the Wabash Lowland (Figure 4). Only a very small area located at the southwestern corner is included in the Wabash Lowland region.

In respect to its physiographic situation in the United States, the county lies wholly within the Till Plain section of the Central Lowland province (7).

U S DEPARTMENT OF COMMERCE, WEATHER BUREAU
IN COOPERATION WITH PURDUE AGRICULTURAL EXPERIMENT STATION
CLIMATOGRAPHY OF THE UNITED STATES NO 20 - 12

LATITUDE 39° 39' N.
LONGITUDE 86° 51' W.
ELEV. (GROUND) 835 Ft.

CLIMATOLOGICAL SUMMARY

STATION GREENCASTLE, INDIANA

MEANS AND EXTREMES FOR PERIOD 1934-1963

Month	Temperature (°F)							**	Precipitation Totals (Inches)								Mean number of days					Month
	Means			Extremes				Mean degree days				Snow, Sleet					Precip. .10 inch or more	Temperatures				
																		Max.		Min.		
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year		90° and above	32° and below	32° and below	0° and below	
(a)	30	30		30		30		30	30	30		30	30		30		10	27	27	27	27	
Jan.	38.0	21.2	29.6	71	1950	-13	1940	1073	3.00	4.56	1950	4.8	15.9	1956	5.4	1937	5	0	10	26	2	Jan.
Feb.	41.0	23.0	32.0	73	1957	-20	1951	913	2.33	2.26	1956	4.7	19.4	1961	9.0	1960	6	0	6	23	1	Feb.
Mar.	50.5	30.9	40.7	81	1945	-8	1943	763	3.48	2.39	1953	4.3	19.8	1960	7.5	1953	7	0	2	18	*	Mar.
Apr.	63.1	41.6	52.4	89	1954	19	1950+	378	3.81	2.47	1956	0.7	6.1	1940	6.0	1940	7	0	0	6	0	Apr.
May	73.8	51.7	62.8	93	1962+	28	1947	149	4.85	3.58	1961	T	T	1960+	T	1960+	8	1	0	*	0	May
June	83.3	61.1	72.2	105	1954	39	1945	27	5.30	6.50	1952	0	0		0		7	6	0	0	0	June
July	87.2	64.0	75.6	108	1936	46	1937	0	3.59	4.63	1962	0	0		0		6	10	0	0	0	July
Aug.	86.0	62.6	74.3	102	1955	42	1934	0	3.56	5.12	1934	0	0		0		5	9	0	0	0	Aug.
Sept.	79.4	55.0	67.2	106	1954	28	1942	81	3.85	6.35	1950	T	T	1951+	T	1951+	4	4	0	*	0	Sept.
Oct.	68.5	44.9	56.7	93	1953	19	1962+	291	2.66	2.30	1959	T	1.2	1962	1.0	1962	6	*	0	3	0	Oct.
Nov.	51.3	33.1	42.2	85	1950	-6	1950	681	3.29	2.35	1938	1.8	7.1	1950	5.0	1950	6	0	2	15	*	Nov.
Dec.	39.8	23.6	31.7	70	1959	-14	1951	1017	2.51	2.16	1956	5.1	13.3	1963	6.5	1943	6	0	8	24	1	Dec.
Year	63.5	42.7	53.1	108	July 1936	-20	Feb. 1951	5373	42.21	6.50	June 1952	20.9	19.8	Mar. 1960	9.0	Feb. 1960	76	30	28	116	4	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

\+ Also on earlier dates, months, or years.

* Less than one half.

CLIMATE OF GREENCASTLE, INDIANA

Greencastle, located in Putnam County in West Central Indiana, has an invigorating climate because of the frequent changes of the weather. Pleasant, cloudless days are interspersed with some rainy days throughout the year. Monsoon rains are unknown but rainfall is usually adequate in all seasons favoring a diversified agriculture. In the summer when moisture utilization is high, a dry month of below normal rainfall affects lawns, pastures, and crops.

Weather changes every few days come from the passing of weather fronts and associated centers of low and high air pressure. In general, a high brings lower temperatures, lower humidity and sunny days. An approaching low brings increasing temperatures, increasing southerly wind, higher humidity, and commencement of rain or showers. This activity is greatest in the spring and least in late summer and early fall.

Precipitation is rather evenly distributed throughout the year, a happy contrast to some areas of the United States that have a "dry season" and require irrigation to maintain green vegetation. The table of monthly rainfall for past years in this report shows the variation of rainfall that may be expected. There is a tendency for spring and early summer rains to exceed winter precipitation. The spring rains are very reliable insuring near maximum soil moisture going into summer when evaporation losses exceed rainfall and dry soils become more probable. A severe drought has never been experienced. About one-third of the annual rainfall flows into streams and out of the area. Future needs may require conservation of this water.

The probability for unusually heavy rains in just a few hours is indicated by a weather study of the area:

Frequency in 100 years	Rain in 1 hour	6 hours	12 hours
4	2.4	4.0	4.6
10	2.1	3.3	3.8
20	1.7	2.8	3.2

Snowfall has varied reception. None occurs in the summer. Some winters have much snow and others have very little. An occasional snow storm may hamper travel and clog roads but at the same time the snow blanket protects winter grains from the very cold air that invariably follows. Heaviest snow storms are those out of the southwest. As they swirl northeastward, abundant moisture flows in from the Gulf of Mexico. A storm out of the northwest, with an inward flow of colder, drier air, leaves less snow. Some mid-winters are thus cold but snowfall is normal or less.

Relative humidity is not measured at this station but estimates are possible from the climatology of the area. Relative humidity varies on sunny summer days from a percent in the 40's in the early afternoon to the 90's about sunrise. Relative humidity rises and falls much as temperature does during a typical day but the highest percent usually occurs with the minimum temperature and the lowest percent with the maximum temperature. A cold front is next in importance in changing relative humidity downward.

Winds blow most frequently from the southwest, however, in one or two of the winter months, prevailing winds are northwest. Damaging winds have three sources. In the order of diminishing area coverage but increasing intensity, they are: lows passing through the region, thunderstorms, and tornadoes. Only 6 tornadoes have been reported in the county since 1916. Very few were of sufficient size to injure people and property. Thunderstorms, including incidences of lightning and thunder, occur about 47 days of the year. Most of these occur in the spring and early summer. They are seldom so severe as to cause loss of life, property, or crops. Death dealing smog or fog is unknown.

Heating degree days in the above table provide a comparative number for calculating heating requirements between different places and different times. Fuel consumption for heating is proportional to degree day totals, so a month with twice the heating degree days of another month requires twice as much fuel for heating. Degree days for a single day are obtained by subtracting the mean temperature from 65 degrees.

The growing season (defined here as the number of days between the last spring and first fall temperature of 32°) averages 175 days in length. The season is 195 days or more in 10% of the years, 185 days or more in 25% of the years, less than 165 days in 25% of the years, and less than 155 days in 10% of the years.

Many days of the year are nearly ideal in temperature. A few days in the summer when temperatures exceed 90, or decline below zero in the winter, tend to obscure this fact. The fall season is considered by many as the best time of year for outdoor activities. Spring is also a favorite season but actually this season has more days of rain and thunderstorms. In the fall the atmosphere in total seems more quiet. Air and soil temperatures are nearer in agreement than any other time of the year, thus, convective activity is diminished. Many days are sunny and showers are less frequent.

Lawrence A. Schaal
Weather Bureau State Climatologist
Purdue University, Agronomy Department
Lafayette, Indiana

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1934	34.0	24.1	37.0	52.4	65.8	77.2	80.2	72.9	65.0	56.2	45.8	29.6	53.4
1935	31.0	33.8	47.8	49.1	57.6	67.1	76.5	74.6	65.5	55.0	41.3	25.1	52.0
1936	22.0	22.3	44.6	47.6	65.0	71.8	82.0	79.5	69.6	54.2	38.5	35.8	52.7
1937	33.2	31.3	37.8	51.4	62.2	70.2	73.0	75.4	63.7	53.0	39.4	29.2	51.6
1938	29.0	39.8	48.2	54.5	61.8	68.9	74.5	74.7	68.2	58.7	45.6	33.4	54.8
1939	35.2	32.5	44.1	49.2	64.2	72.0	74.0	72.6	71.8	58.2	41.7	35.8	54.3
1940	15.9	32.2	38.4	49.7	59.0	72.4	74.2	74.7	64.2	59.0	41.4	37.0	51.6
1941	30.9	28.0	36.6	57.9	65.6	71.3	75.0	74.3	69.6	59.2	45.0	38.6	54.3
1942	30.1	28.8	44.6	56.6	62.8	70.9	74.9	71.8	64.6	56.8	46.3	28.7	53.1
1943	30.8	34.7	37.9	50.8	62.2	74.4	75.0	74.6	62.6	55.2	40.2	30.6	52.4
1944	34.4	34.7	38.6	51.5	68.8	75.6	76.0	75.0	68.0	56.2	45.6	26.8	54.2
1945	25.0	34.6	53.4	55.1	59.0	69.2	73.2	73.6	68.8	54.3	44.0	26.2	53.0
1946	31.2	36.0	54.2	55.3	60.4	72.0	75.5	70.0	67.2	60.5	47.5	37.4	55.6
1947	34.6	24.6	34.8	52.5	59.6	69.4	71.0	80.1	67.8	63.8	38.2	33.5	52.5
1948	23.0	32.7	42.2	57.0	62.0	74.0	76.3	74.2	68.4	53.2	47.1	35.4	53.8
1949	34.9	35.1	41.1	51.7	64.3	75.4	80.2	74.6	62.2	60.4	42.8	35.2	54.8
1950	37.1	31.7	37.0	46.4	63.4	70.9	73.4	71.3	64.8	59.9	36.9	23.6	51.4
1951	30.5	30.1	38.3	49.2	64.6	70.9	74.9	72.6	63.8	58.3	34.5	29.9	51.5
1952	32.2	35.3	40.1	53.5	61.7	76.9	77.2	71.8	66.6	51.2	44.6	34.4	53.8
1953	32.9	36.0	43.2	48.2	64.7	77.0	76.0	75.3	68.5	60.0	44.4	32.7	54.9
1954	29.9	39.5	37.8	56.7	59.0	76.8	78.4	75.1	70.8	56.4	41.3	31.7	54.5
1955	27.2	31.6	41.4	58.5	63.5	66.9	80.4	78.0	71.3	56.2	38.8	28.6	53.6
1956	27.8	33.1	41.0	49.6	63.5	73.3	74.4	74.1	65.8	60.5	42.2	37.6	53.6
1957	23.1	36.5	40.7	53.3	63.8	73.3	75.2	74.4	65.0	52.5	41.3	35.7	52.9
1958	28.8	23.9	35.7	53.0	61.8	67.8	73.2	72.9	66.2	55.1	44.4	23.2	50.5
1959	24.2	31.5	39.1	53.8	66.3	72.5	74.8	77.4	68.5	54.7	37.8	36.0	53.1
1960	30.8	27.9	26.0	56.7	59.0	69.3	72.8	74.6	70.9	55.0	43.8	25.6	51.1
1961	24.4	35.3	43.8	46.4	57.0	69.3	74.2	73.1	70.7	56.7	41.9	29.7	51.9
1962	24.3	30.8	36.8	51.3	69.9	72.5	73.6	73.2	63.5	57.1	42.3	26.3	51.8
1963	18.7	22.1	41.2	54.7	61.3	72.2	74.2	71.0	66.2	63.1	45.2	19.3	50.8
1964	31.2	29.5	39.4	54.3	67.0								

STATION HISTORY

This study of local climate is possible because a citizen of the community generously donated for many years a few minutes a day, seven days a week, reading and recording weather information from government instruments. The present observer is Grafton J. Longden, Jr. His weather station has been located one mile east of the Greencastle post office since January 22, 1947. Earlier observers, dates of service, and location if known are: Guy Wilson, September 10, 1895 to June 30, 1898; H. A. French, April 25, to August 31, 1899; M. V. Brown, September 1, 1899 to July 31, 1905; William Blanchard, November 1, 1905 to October 4, 1906; E. Hawkins, August 1, 1915 to December 31, 1915, at 18 South Vine Street; J. P. Allen, January 7, 1916 to June 21, 1924; John H. Goddard, June 21, 1924 to February 20, 1928, 3 blocks west of the post office; Ernest Rice Smith, February 21, 1928 to November 22, 1943, and September 1, 1946 to January 20, 1947, 3/4 mile southeast of the post office at 309 Greenwood Avenue; Kenneth W. Bennett, November 23, 1943 to January 31, 1944, 0.4 mile south of the post office at 10 Park Street; and Orrin H. Smith, April 19, 1944 to August 31, 1946, 3/4 mile southwest of the post office at 310 Greenwood Avenue. Some of the time exposure of instruments was non-standard being over cultivated ground in the period of 1928-1943, and 1946-1947. The variation of station elevation above sea level at these locations is probably not significant climatologically.

EXTREMES AND DATES OF OCCURRENCE (1895-1963)

Month	Highest Temperature		Lowest Temperature		Greatest Daily Precipitation		Greatest Monthly Snowfall	
Jan.	71	1/26/50	-21	1/12/18	4.56	1/4/50	19.5	1918
Feb.	74	2/10/32	-20	2/2/51	2.48	2/25/26	19.9	1905
Mar.	86	3/24/29	-8	3/8/43	3.82	3/25/04	26.5	1906
Apr.	90	4/11/30+	17	4/1/23	3.40	4/11/22	6.1	1940
May	95	5/30/19	28	5/9/47	4.16	5/30/05	0.5	1897
June	105	6/27/54	36	6/16/17	6.50	6/21/52		
July	108	7/8/36	41	7/20/29	4.63	7/14/62		
Aug.	105	8/5/18	42	8/29/34	5.12	8/19/34		
Sept.	106	9/6/54	26	9/26/28	6.35	9/1/50	T	1951
Oct.	95	10/2/19	18	10/29/25	3.27	10/12/01	1.2	1962
Nov.	85	11/1/50	-6	11/25/50	2.35	11/18/38	7.1	1950
Dec.	70	12/28/59	-18	12/28/24	2.60	12/13/01	13.3	1963

Year	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1934	1.28	0.49	2.41	2.38	1.13	3.44	2.53	10.35	6.92	0.27	3.65	2.07	36.92
1935	2.47	0.46	2.14	1.71	8.05	3.97	4.34	2.34	2.86	1.08	4.59	1.58	35.59
1936	1.24	2.63	1.79	3.64	1.52	0.66	1.14	2.34	6.76	4.69	3.90	2.96	33.27
1937	8.74	1.79	2.19	5.56	4.36	5.28	3.00	4.30	3.34	6.90	1.67	3.76	50.89
1938	1.17	3.08	9.25	3.92	6.03	5.07	7.42	4.95	1.24	1.04	4.37	2.11	49.65
1939	5.69	3.78	3.89	6.24	1.98	5.76	3.62	1.93	0.79	2.40	1.65	1.19	38.92
1940	1.91	2.15	1.79	6.16	6.05	5.51	1.00	3.35	1.21	1.42	4.13	3.11	37.79
1941	1.33	0.83	1.13	2.77	2.67	14.32	1.37	1.81	4.10	6.92	3.62	1.79	42.66
1942	1.36	4.03	3.08	3.05	5.86	7.70	4.73	2.65	2.68	1.44	5.42	2.22	44.22
1943	1.27	1.11	2.67	2.57	11.56	1.85	3.33	2.79	4.50	1.34	3.38	1.84	38.21
1944	0.26	2.75	3.61	7.01	3.45	4.30	2.51	3.89	1.43	1.25	3.05	1.36	34.87
1945	0.63	2.28	7.90	4.35	5.61	8.23	2.82	4.11	6.50	2.27	4.59	2.94	52.23
1946	1.60	2.96	2.32	1.21	11.06	1.88	1.89	3.51	1.44	2.31	3.77	3.88	37.83
1947	3.49	0.19	2.20	5.99	4.66	7.76	2.43	8.64	5.29	2.10	1.65	1.32	45.72
1948	2.18	2.15	7.41	2.18	3.45	4.77	4.90	-	3.59	2.52	5.23	3.21	-
1949	7.53	2.36	3.33	-	3.79	5.22	4.23	2.99	1.58	5.08	1.11	3.46	-
1950	13.68	4.59	3.83	4.72	1.10	6.29	3.18	1.32	14.32	1.20	5.62	2.10	61.45
1951	2.76	-	-	3.26	3.94	5.54	9.04	2.20	2.69	3.67	3.16	-	-
1952	3.25	2.39	5.21	4.15	3.41	9.11	2.26	2.66	2.72	0.36	3.28	2.07	40.87
1953	2.41	1.46	6.19	3.58	3.94	4.68	5.58	1.20	0.92	2.20	1.33	1.73	35.22
1954	2.51	2.37	3.25	2.27	2.64	1.80	2.87	3.18	1.25	4.62	1.49	2.78	31.03
1955	2.81	2.24	3.57	3.63	4.46	4.04	4.11	0.83	7.58	4.05	4.21	0.91	42.44
1956	1.41	5.23	1.50	5.69	5.04	5.12	2.82	3.45	1.61	2.18	3.11	4.56	41.72
1957	3.46	2.23	2.02	6.98	6.43	10.30	3.56	5.69	1.33	4.08	4.68	7.25	57.96
1958	1.49	0.34	1.52	2.61	4.07	8.33	7.00	4.17	4.39	2.09	4.39	0.16	40.56
1959	3.97	3.30	3.36	5.48	2.09	2.40	2.11	3.68	3.77	4.17	3.12	2.99	40.44
1960	2.62	3.73	1.61	1.56	5.21	6.71	2.00	4.54	2.33	1.39	2.89	2.29	36.88
1961	0.94	2.60	6.00	5.07	6.47	5.86	2.73	3.49	3.49	2.68	3.39	2.73	45.45
1962	4.52	2.32	3.68	1.40	5.99	2.93	8.18	3.02	11.02	1.63	1.45	1.40	47.54
1963	1.11	0.70	8.12	3.15	2.59	1.58	5.15	4.79	0.14	0.16	2.45	0.89	30.83
1964	1.51	2.15	6.46	8.39	1.92								

PROBABILITY OF LOW TEMPERATURES IN SPRING AND FALL

Minimum Temp.	Percent of occurrence after the date in spring					Percent of occurrence before the date in fall				
	90%	75%	50%	25%	10%	10%	25%	50%	75%	90%
40	5/5	5/12	5/20	5/28	6/4	9/16	9/22	9/28	10/4	10/10
36	4/27	5/3	5/9	5/15	5/21	9/21	9/27	10/4	10/11	10/17
32	4/14	4/20	4/27	5/4	5/10	10/5	10/11	10/19	10/27	11/2
28	3/25	4/1	4/10	4/19	4/26	10/16	10/23	10/31	11/8	11/15
24	3/6	3/15	3/25	4/4	4/13	10/27	11/2	11/9	11/16	11/22
20	2/26	3/7	3/16	3/25	4/3	11/4	11/12	11/20	11/28	12/6
16	2/13	2/23	3/6	3/17	3/27	11/16	11/25	12/4	12/13	12/22

This table summarizes for a 30-year period the dates when low temperatures such as 32°F. last occurred in the spring and first occurred in the fall. The average date is given in the 50% column. The table shows that the last temperature of 32° or lower in the spring occurs after May 4 in 25% of the years, and before October 11 in the fall. Probabilities for other temperatures are indicated. Reference: "Risks of Freezing Temperatures--Spring and Fall in Indiana," by L. A. Schaal, J. E. Newman, and F. H. Emerson.

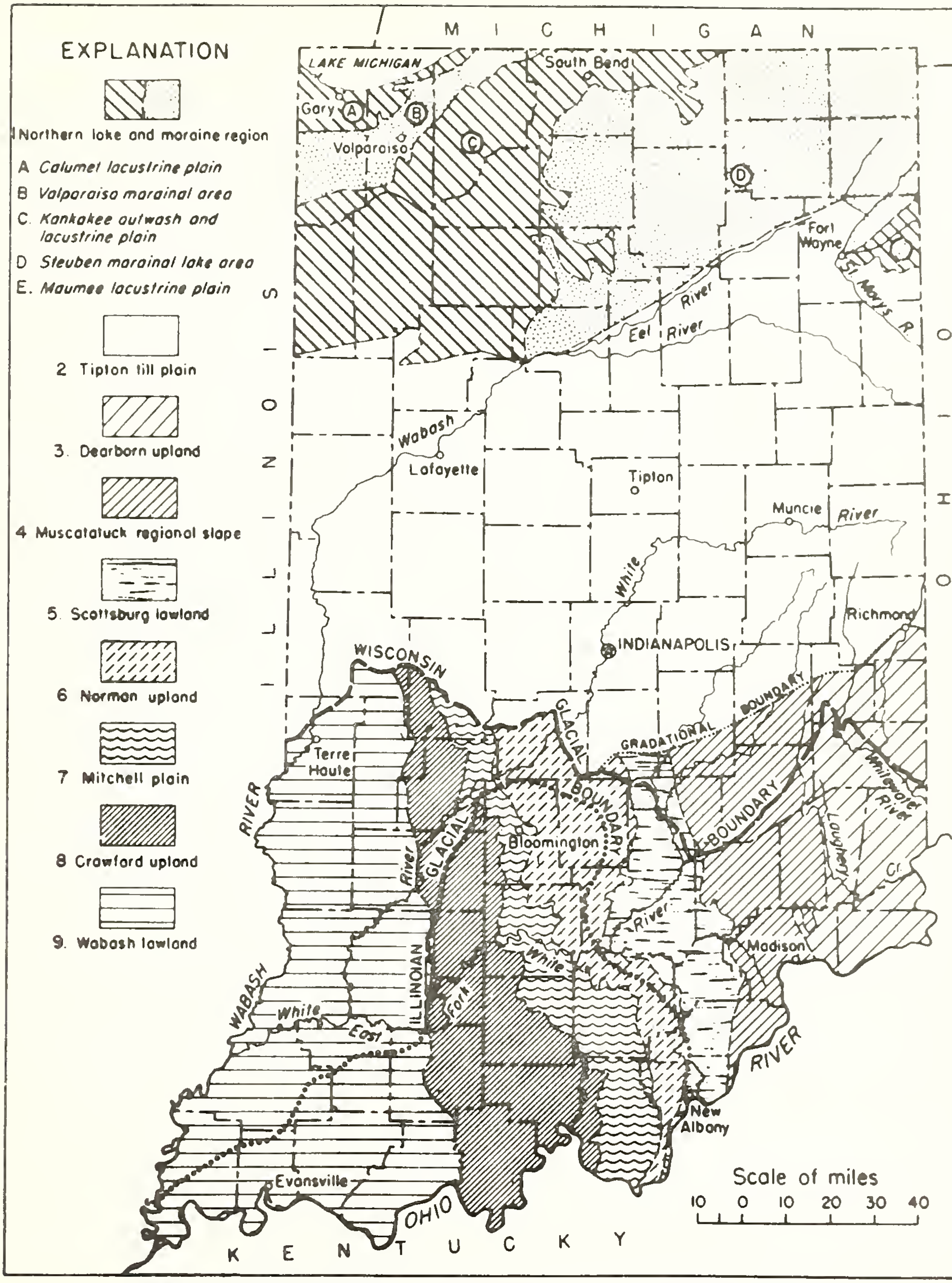


Figure 4 Map of Indiana showing regional physiographic units based on present topography. Modified from Malott

Topography

Putnam County is in general an undulating or gently rolling glacial plain broken by stream dissection (See Figure 5). Although the county is covered by the deposits of two different glaciers namely the early Wisconsinan on the northeast and Illinoian at the southwest, little or no conspicuous topographic distinction exists.

Rough topography is found along the valleys of Big Raccoon, Big and Little Walnut and Mill Creeks and their larger tributaries. The valley slopes are precipitous in many places and the bluffs are about 100 feet (30.5 m) high in general. The interstream areas are generally undulating or gently rolling, but are marked in places by prominent ridges, knobs and flats.

There are three relatively flat upland areas in Putnam County. All of them are different in their origin. The one located on the northeast portion of the county is in the Wisconsinan till plain area. The one that lies southeast of Cloverdale is in the Illinoian till plain and lacustrine area. The third one occupies a six-mile (9.65 km) strip along the western county line is composed of about 70 incles (1.78 m) of windblown loess on Illinoian till.

Most of the ridges and round knobs scattered over the southern half of the county have limestone sinkholes on their slopes. Those without sinkholes are capped by sandstone and shale formations.

Flood plains along the major river and streams are mainly broad level plains with a maximum width of one mile (1.6 km) along Eel River but in a few places the channel lies in

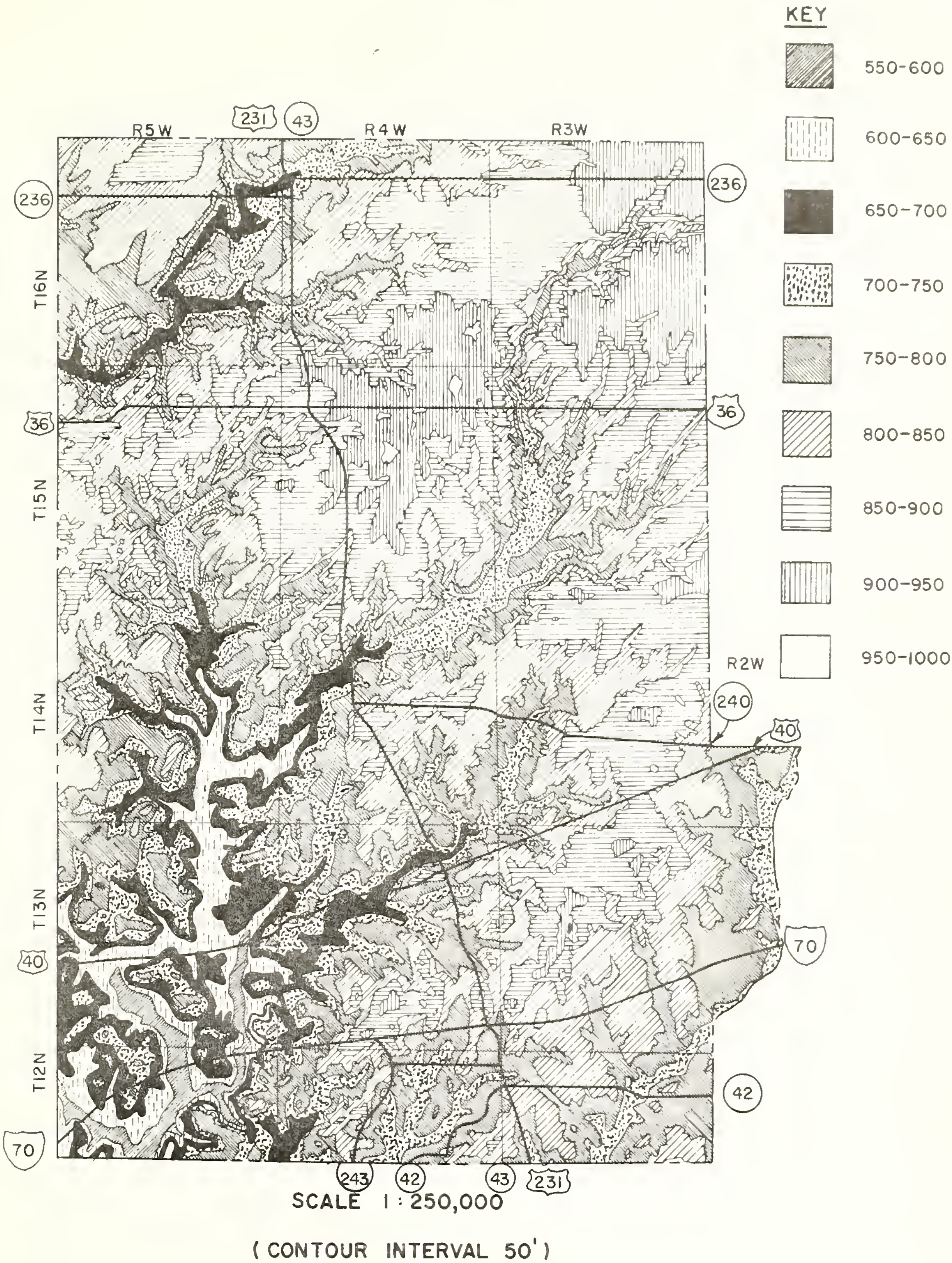


FIG. 5 TOPOGRAPHIC MAP OF PUTNAM COUNTY

narrow gorges. Rock control is evident along the river channels. Terraces are found along Big Raccoon Creek, Big Walnut and Little Walnut Creeks and Mill Creek at the south-eastern corner of the county. They are generally flat in topography and slightly higher than the flood plain.

Sand dune formations are limited to the bluff of Big Walnut Creek and Mill Creek. None of them are outstanding in their characteristic topography.

A narrow esker ridge about two miles (3.2 km) in length is located about seven miles (11.2 km) northeast of Greencastle. The esker is almost in a straight north-northeast course. The northern portion is now destroyed by the construction of Heritage Lake.

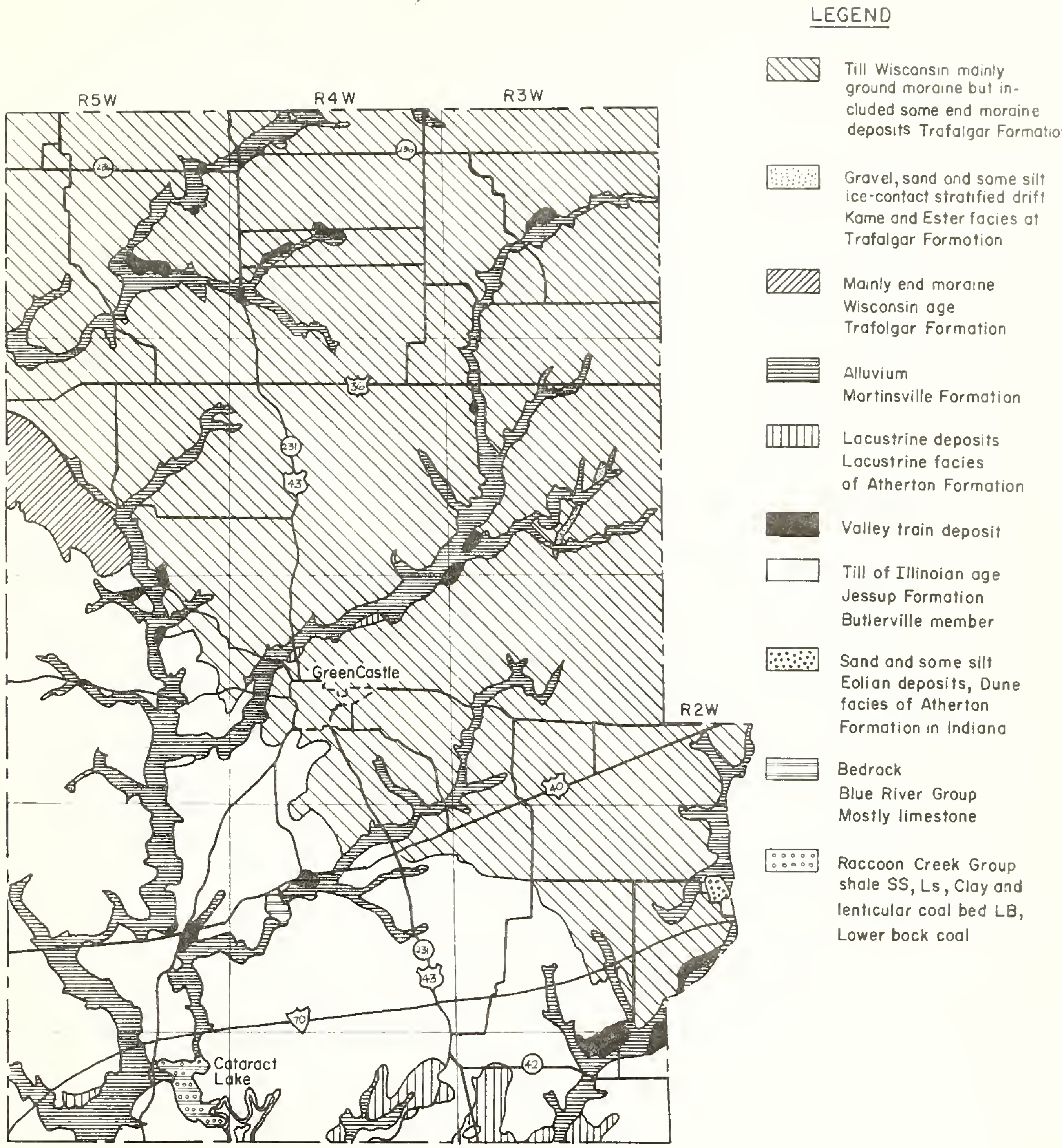
The highest elevation of Putnam County is about 980 feet (300 m) located on a knob at the NE$\frac{1}{4}$ of NW$\frac{1}{4}$ of section 15, T.15N., R.4W. on the site of a limestone quarry. The lowest elevation is about 570 feet (174 m) above sea level located along Eel River where it leaves the county. Local relief from 130 to 210 feet (40 m to 64 m) is found along the bluffs at Big Raccoon Creek and Little Walnut Creek. However, the maximum local relief of 230 feet (70 m) may be found on a mound near Cataract Lake located within the State Forest and Richard Lieber State Park just west of SR 243 at the SE quarter of sec. 18, T.12N.,R.4W.

Geology

The surface and near surface ages represented in Putnam County are the quaternary period and the bedrock of paleozoic age. The quaternary materials are both pleistocene and recent in age.

The general surface deposits of the county are shown in Figure 6. About two thirds of the surface deposits on the north and eastern portion of Putnam County are the ground moraine of the Wisconsinan age classified as Center Grove Till Member of the Trafalgar Formation by Wayne (8). The southwestern third of the county is covered by till of the Illinoian age classified as the Butlerville Till Member of the Jessup Formation. End moraines of Wisconsinan age located near the western border of the county. An outstanding esker lies near the eastern border of the county. Considerable amount of alluvial deposits of the Matinsville Formation occur within the county. Small areas at the southeastern corner of the county are lacustrine deposit of glacial Lake Quincy that extended from Owen County and is classified as the Lacustrine Facies of the Atherton Formation. Terrace or valley train deposits are scattered along the major drainage channels. Sandy eolion deposits or dune facies of the Atherton Formation are very limited in Putnam County. They are confined to the bluffs along Mill Creek and near the mouth of Walnut Creek.

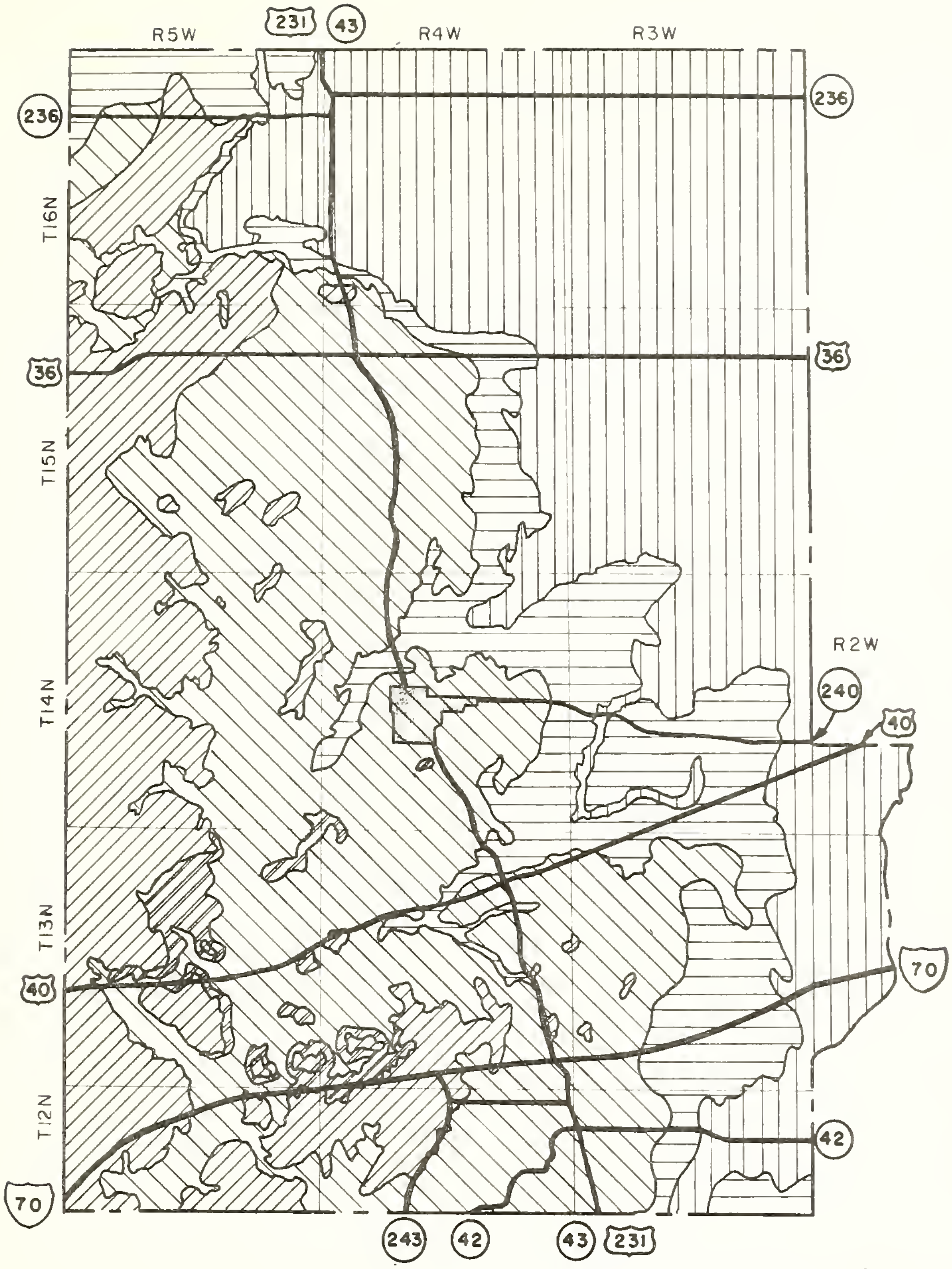
The bedrock underneath the unconsolidated surface materials are of Pennsylvanian and Mississippion periods. About three quarters of the county is underlain by the Mississippian rock formation. The Pennsylvanian rocks occur along the western quarter (See Figure 7). The Pennsylvanian rocks belong to the Raccoon Creek group which consists of shale and sandstone with occassional limestone, clay and lanticular coal beds.



FROM GEOLOGIC MAP OF INDIANAPOLIS $1^{\circ} \times 2^{\circ}$ QUADRANGLE

SCALE 1 : 250,000

FIG. 6 SURFACIAL GEOLOGIC MAP OF PUTNAM CO.



FROM GEOLOGIC MAP OF INDIANAPOLIS $1^{\circ} \times 2^{\circ}$ QUADRANGLE

SALEM LIMESTONE AND MAJOR PART OF HARRODSBURG LIMESTONE
Mostly limestone

LOWER PART OF HARRODSBURG LIMESTONE, BORDEN GROUP, AND ROCKFORD LIMESTONE Siltstone, shale, sandstone and some limestone

RACOON CREEK GROUP
Shale, sandstone, limestone, clay and lenticular coal beds

BLUE RIVER GROUP
Mostly limestone

WEST BADEN GROUP
Shale, sandstone, and limestone

FIG. 7 BEDROCK GEOLOGY OF PUTNAM COUNTY

Four different groups of rocks of the Mississippian period are found in Putnam County. The uppermost Mississippian rocks are shale and sandstone with some formations of limestone of the west Baden Group. It occupies several small areas in the southwestern quarter of the county (See Figure 7). Blue River Group is the next rock group to the east. It contains mostly limestone with Ste Genevieve Formation at the top and St. Louis Formation underneath. Further east Salem limestone formation and Harrodsburgh limestone formation are found.

The northeastern quarter and the eastern strip of the county is underlain by the lowermost part of the Harrodsburg Limestone, the Borden Group and the Rockford limestone. This group consists of siltstone, shale, sandstone and some limestone.

A generalized stratigraphic column of the Pennsylvanian and Mississippian formation in this area is shown in Figure 8.

Bedrock exposures are numerous at deep cuts of highways and railroads. Many drainage channels are entrenched into the bedrock. Surely stone quarries give excellent exposures of the rock formations. A good rock exposure of the Pennsylvanian period occurs at the spillway of the Gagle Mill Dam of Cataract Lake at Sec. 13, T.12N., R.5N.

The thickness of drift and bedrock outcrop of Putnam County is shown in Figure 9.

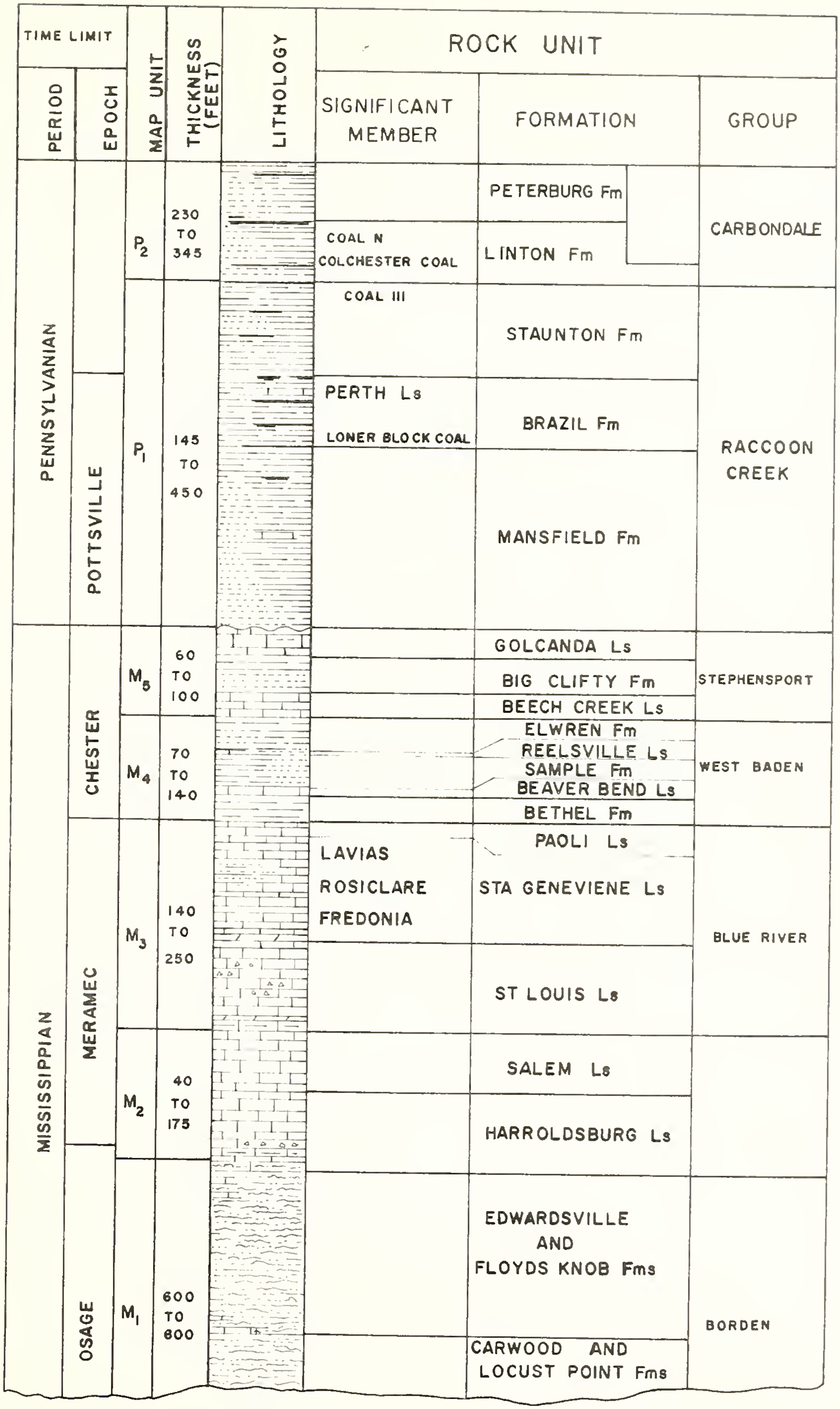


FIG. 8 GENERALIZED STRATIGRAPHIC COLUMN OF MISSISSIPPIAN AND PENNSYLVANIAN FORMATION IN INDIANA

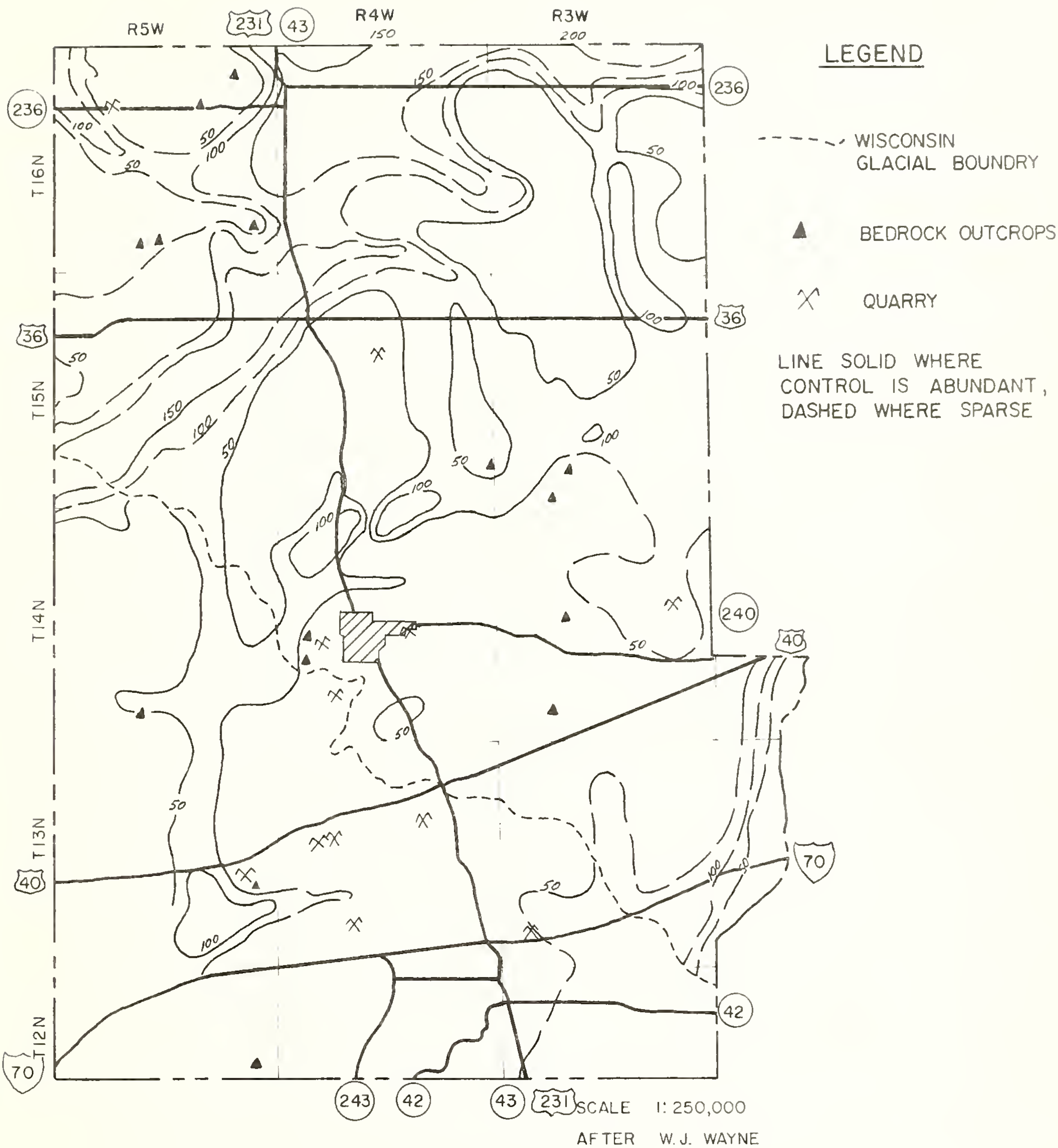


FIG. 9

THICKNESS OF DRIFT AND BEDROCK IN PUTNAM COUNTY

LAND FORM AND ENGINEERING SOIL AREAS

The engineering soils in Putnam County are derived mainly from unconsolidated materials (See Figure 6 and Figure 9). The unconsolidated materials include glacial deposits, glacial fluvial deposits, alluvial deposits and eolian deposits. A very limited area may be considered as a residual soil or non-soil area. However, due to the scale limitation of the attached map many narrow strips of rock outcrops along the valley wall of the major streams of the county cannot be shown. The stone quarry areas, as indicated on the map, should be considered as non-soil area.

The deposits of transported materials are not homegeneous and variation should be expected. General properties and profiles of the soils for each area of different land form, are presented in this report.

The entire county is covered by loess of various depth. In the Wisconsinan glacial area the loess mentle is about 40 to 50 inches (100 to 127 cm) in depth on the least erosive flat land. The depth of the loess is thicker in the Illinoian glacial region. It varies from about 55 inches (140 cm) to more than 72 inches (183 cm) on the near level land (9). Since most of the loess mantle is less than six feet (183 m), it is not considered as a separate landform in this report.

Glacial Deposited Materials

Essentially all the soils of Putnam County are of glacial origin. The major portion of the county on the northeast is

covered by glacial deposit of the early Wisconsinan age classified as the Center Grove Till member of the Trafalgar Formation. The southwestern part of the county is covered by glacial drift of Illinoian age called the Butlerville Till Member of the Jessup Formation.

Owing to the long period of weathering and erosion the end or ridge moraine of the Illinoian age is no longer visible. In the Wisconsinan glacial region, however, the terminal moraine and eskers can be recognized.

Many hills or knobs occur in the southern half of Putnam County. This is the areas of thin glacial drift over sandstone and shale or limestone bedrock. The various landforms are discussed as follows:

1. <u>Ground Moraine of Illinoian Age with Thin Loess Mantle</u>

Ground moraine deposits of the Illinoian Age with a loess mantle less than six feet (1.8 m) occupies the southwestern part of Putnam County. A thicker than six feet (1.8 m) less deposits occur along a narrow strip of nearly level land along the border with Clay County in T.14N. and on a flat land adjacent to the stream of Doe Creek southwest of Cloverdale (mapped as lacustrine deposit in Figure 6). Since the area involved is rather small no separation is made in this report.

The topography of this ground moraine varies from nearly level to gently undulating. At the highly dissected area a rolling topography may be present. Gullies along the major streams are deeply incised into the upland giving the area a rugged look. Many areas are still under timber cover, especially

along the steep valley walls of the streams. The well developed white fringe along the dark centered gullies is the typical airphoto pattern of this deposit.

The upper horizon of the solum is derived from the loess material. The thickness of the loess cover depends greatly on the topography and the distance from the river. The greater the distance the thinner the deposit. On steep slopes where erosion is severe, the loess mentle may have been removed.

The soil profile shows that the A-horizon is a silt loam or silty clay loam (A-4 soil). Silty clay or clay (A-6 or A-7-6 soil) is encountered in the B-horizon. A leached parent material is found with a texture from a silt loam to a clay (A-6 soil).

Boring data along Interstate I-70 reveal some of the characteristics of the thin loess covered Illinoian drift deposits (See Appendix A). The samples taken from the borings on the level upland areas agree closely with the profile description. However, local variation due to topography and the influence of bedrock should be expected. For instance: a sandy clay loam (A-4 soil) is found six inches (15 cm) below the top soil where sandstone bedrock is encountered four feet (1.2 m) below the surface at boring site #12. Shale occurs six feet down from the surface at boring site #52 where the surface soil from 0-1.5feet (0-45 cm) is a clay (A-4 soil). Boring sites from #73 to #75 are also on shallow rocks. At the vicinity of site #85 rocks are found from 4 to 12.5 feet (1.2 to 3.8 m) below the surface and a sandy clay loam (A-2-4) with rock fragment occured at a depth from 8.5 to 9.5 feet (2.6 to 2.9 m)

below the surface at the site.

A coarser texture such as silty clay loam, sandy clay loam or loam (A-4 to A-6 soil) may be found on the gully wall, gully bottom and depression as illustrated at the boring sites Nos. 37,38, 43, 44, 45, 46, 63, 98, 99, 102 and 105. The reader may gain a better understanding of the profile by refering to the boring reports (10, 11, 12, 13).

As illustrated in Figure 9, the thickness of the drift is rather thin especially at the south central portion. Rock may occur at a shallow depth especially on the gully wall and gully bottoms. Some well logs of Putnam County may give the reader a better picture of the subsurface condition of the county (14). Sandstone and shale bedrocks are encountered at a depth from four to eight feet (1.2 to 2.4 m) below the surface at a number of places located along the bluff of the creeks in T.13N., R.4W. and R.5W.

Engineering problems associated with this soil area are those of low strength when wet, difficulty of compaction, drainage and erosion of side slopes. Along the valley wall in the western portion cuts may encounter different types of sedimentary rock.

2. <u>Thin Illinoian Drift over Limestone</u>

The thin Illinoian drift over limestone areas are scattered throughout the Illinoian drift region except the southwestern corner of the county. The deposit is generally slightly higher than the surrounding ground moraine deposit and has a gently undulating, sinkhole studded topography.

The sinkholes are variable in size, depth and also in density. The deposit sometimes is associated closely with sandstone and shale cap rocks and becomes the slope former. With the sinkhole pattern the area is easy to delineate.

The soil of this area is developed in 10 to 50 inches (25 to 127 cm) of loess over weathered Illinoian till that is underlain by material weathered from limestone. Depth of bedrock ranges from 3 to 8 feet (0.9 to 2.4 m).

The soil profile of this area consists of a silt loam topsoil and a clayey subsurface soil. On steep slopes where erosion is severe the silt loam topsoil may be removed and the clayey subsurface soil exposed. This subsurface soil is underlain by silty clay and then silt loam derived from the Illinoian drift. Before the unweathered limestone bedrock is reached a layer of red clay is encountered. This layer of highly plastic clay is the result of the weathering of the limestone.

At the bottom of the sinkhole, the soil is derived from wash in materials. Underneath the silt loam to silty clay loam topsoil a sandy clay loam or silty clay may be encountered. A layer of clay is usually encountered before reaching the limestone bedrock.

The boring data in site #76 and #77 is not deep enough to encounter the limestone bedrock. However, borings about 200 feet (61 m) east of #75 where a number of sinkholes are located some weathered sandstone and sandstone fragments were encountered

before the limestone bedrock (12). This is a good indication of the collapsing of sandstone roof over the solution cavity.

Cut and fill of the irregular rock surface, sinkhole pluging and/or fill stability are the problems generally found in this area.

3. Thin Illinoian Drift over Sandstone-Shale

The thin Illinoian drift over sandstone-shale areas are confined to the southwestern portion of Putnam County. It is scattered as ridges and mounts within the Illinoian drift region and as steep valley walls adjacent to the valley along Cataract Lake and the valleys near the junction of Mill Creek, Deer Creek and Eel River.

The deposit is a ridge former and it occupies the highest position topographically. On the eastern portion of the region, the deposit is associated with the thin Illinoian drift over limestone formation that occupies the sloping areas below the ridge. The Illinoian drift on limestone formation lies on the slope between the sandstone-shale ridge and the ground moraine of Illinoian drift which forms a plain below the low ridges.

Along the major drainage channels the deposits are confined to the valley wall, between the Illinoian drift upland on one side and the stream bottom on the other. The topography in this area is more rolling and dissected. The land is mostly used for timber because of the steep slope.

The soil in this area is developed from a blanket of loess (less than 48 inches (122 cm) in thickness) underlain by weathered Illinoian drift and sandstone-shale. The upper soil profile is essentially the same as the soil of the loess covered ground moraine of Illinoian age. However, the silt loam or silty clay loam topsoil may be absent on steep slopes. The B-horizon consists of silty clay to clay soil. Clay loam and clayey soil form the C-horizon. Generally a layer of sandy clay loam or silty clay with rock fragment may be found overlying the interbedded sandstone-shale. This is the residual soil of the sandstone-shale underlying the glacial material.

Boring sites Nos.34 and 35 are located within the valley wall area. No rock was encountered in these sites. However, borings near the gully bottom and at a point 250 feet (76 m) east of site #35 show that hard shale were encountered at a depth 4.1 to 4.6 feet (1.25 to 1.40 m) from the surface. At these sites the top layer of soil (about 1.5 feet (.46 m) in thichness) is a clay loam or clay overlain a sandy clay loam. Many borings in the valley wall between sites #31 and #32 show that shale were encountered at a depth of 2.5 to 4 feet (.76 to 1.22 m) in the gullies. Thicker soil profiles are on the ridges or between gully areas (11).

Boring sites Nos. 59, 60, 61, 79, 80 and 81 are located on the ridges. Sandstone were encountered at a depth ranges from 3.5 to 12 feet (1.07 to 3.66 m) below the surface. Thicker soil profiles are usually found at the ridge top where erosion is less severe. The soil layer immediately above the sandstone

bedrock varies from a sandy clay loam (A-4) to silty clay (A-7-6 to A-6) or a clay loam (A-4). Rock fragments were usually found in this layer.

In a number of places, where the bedrock is exposed by erosion or by man-made excavation, the areas can be considered as a non-soil area. Since the area is very small in size no attempt was made to include it in the attached soil map. Along the steep valley wall areas near Cataract Lake in Sections 13, 14 and 15 of T.12N.,R.5W. the loess and Illinoian drift deposit may have been removed completely in places. These areas can be considered as residual soil area. Since the area is small and spotty no attempt is made to separate them.

Problems in this area are those of seepage, compaction control and erosion of side slopes. Sandstone-shale bedrock may be encountered in shallow cuts.

4. Ground Moraine of Wisconsinan Age with Thin Loess Mantle

About two thirds of Putnam County is covered by the Wisconsinan drift deposits. The boundary between the Wisconsinan and the Illinioian drift is irregualr as indicated on the soils map. In places where the land surface is smooth the boundary is marked by a definite escarpment or by a long gentle slope to the southwest, but in the rougher or rolling section no conspicuous topographic distinction exist. However, airphoto patterns especially the drainage patterns between these two different drift deposits made the delineation possible.

As indicated in Figure 9 the depth of the Wisconsinan deposits varies greatly from nothing at the rock exposure to over 150 feet (45 m). The topography also varies from near level to rolling. The largest flat topographic land is located on the northeastern corner of the county. Others are found at the northwestern quarter of the county. Undulating topography prevails at the central portion of the region and at places near the drainage channels even gently rolling landscape appear.

The loess mantle over the Wisconsinan drift varies in depth from about 18 to about 60 inches (45 to 152 cm). The thickest loess cover is found near the Clay County border and decreases gradually to the east. Along the valley wall and gully areas loess cover may be removed entirely by erosion. Since the drift deposit is derived from the early Wisconsinan age, the composition, texture and even the color is very similiar to the Illinoian drift.

The soil profiles developed in this region are characterized by a silty loam or silty clay loam A-horizon, a silty clay loam to clay B-horizon and a loam to clay loam C-horizon. In the slightly lower topographic position or depression, the top layer of soil contains considerable amount of organic matter. A higher clay content in the B-horizon is expected.

Boring data from sites Nos. 107 to 150 are entirely in this region. The texture of the B-horizon is generally silty clay to clay (A-7-6 soil) which are composed of from 0-1% of gravel, 5-9% of sand, 44-58% of silt and 37-46% of clay. At the

vicinity of the drainage channel such as sites Nos. 109, 113 114, 115, 116 and 133 the B-horizon is classified as silty clay loam (A-4) soil. The soil is coarser and contained 1% of gravel, 15-23% of sand, 52-57% of silt and 24-27% of clay. The parent material has a clay loam to clay (A-4) to (A-6) texture which contains 1-11% of gravel, 16-40% of sand, 29-52% of silt and 21-35% of clay. Occasionally a sand lense may be encountered. For example, a sandy clay loam is found at site No. 141 at a depth between 5.0 to 6.4 feet (1.52 to 1.95 m) from the surface. A layer of sandy loam (A-2-4) which contains 74% of sand, 17% of silt and 9% of clay is found about 5 feet (1.5 m) below the surface between site No. 147 and the Mill Creek channel.

A coarser textured deposit may be found along the vicinity of major channels especially along Big Raccoon Creek. A sandy gravelly deposit is found along the southern bluff of the valley in sections 28 and 51 of T.16N., R.5W. The deposit is rather small and may be considered as a local variation. A dotted line is used to delineate the boundary and sand and gravel textural symbol is applied.

High water table in the near level and depressional area and the low shearing strength of the somewhat plastic subsoil together with the high compressibility and frost heave are the engineering problems in this region.

5. Ridge Moraine of the Wisconsinan Age with Thin Loess Mantle

The ridge moraine of the Wisconsinan age with thin loess mantle are located on the western central portion of the county.

The moraine belongs to the Shelbyville moraine system extended from Clay County and along the Wisconsinan glacial boundary. Two separate remnants are located just north of the main body. A number of isolated remnants may be found further to the east but it is very small in extent and less prominent therefore no attempt is made to map them.

The main body of the ridge moraine has an undulating to gently rolling topography. The moraine altitude varies from 830 to 860 feet (253 to 262 m) above sea level. It is about 20 feet (6.1 m) higher than the surrounding ground moraine to the north and about 30 to 40 feet (9.1 to 12.2 m) higher than the Illinoian ground moraine to the south. The break to the north is gentle but more abrupt to the south.

The remnant directly north and extending into Clay County also has an undulating topography with an altitude from 840 to 850 feet (256 to 259 m) and about 30 feet (9.3 m) higher than the surrounding ground moraine. The other ridge moraine remnant is also undulating in topography in a north-south direction. It has an elevation of 909 feet (277 m) at the north and decreases to 880 feet (268 m) to the southern tip. Bordering to the eastern edge is a narrow esker like ridge. The break with the surrounding ground moraine is not sharp. However, the ridge moraine is 20 to 40 feet (6.1 to 12.2 m) higher than its surrounding ground.

The thickness of the loess cover varies from about 18 inches to 60 inches (45 to 152 cm). It is thiner at the slopes where erosion is severe. The drift parent material is essentially the same as it is in the ground moraine. Occasionally a coarser

textural deposit is encountered. A slightly pitted pattern is registered in the airphoto and the area is outlined by dotted lines and indicated by sand and gravel textural symbols. The reader should use the coarser half of the soil profile in this area.

The soil profiles in this region show a great range of texture in the A-horizon. At the high position, loam, silt loam, clay loam and silty clay loam may be found while organic silty clay loam to organic clay occurred in the low topographic position. The B-horizon generally is a silty clay to clay in texture except in the coarser deposit where sandy clay loam or sandy clay may be found. The parent glacial drift is a clay loam to clay classification in general except at the coarser textural deposit where sandy loam or loam may be found.

A well drilled at SE$\frac{1}{4}$ of NE$\frac{1}{4}$ of Sec. 19, T.15N., R.5N. recorded a 32 feet (9.8 m) of sand and gravel overlain 20 feet (6.1 m) of gritty drift, then 6 feet (1.8 m) of mud and followed by 31 feet (9.5 m) of sandstone and 11 feet (3.4 m) of shale (14).

Due to the more undulating or rolling topography than the ground moraine region, cut and fill become a problem. The variable strength of the subsoil when changes from a coarser to a finer deposit may create problems.

6. Thin Wisconsinan Drift over Limestone

Thin Wisconsinan drift over limestone areas are confined to the region bounded by the Big Walnut Creek to the north and the Wisconsinan drift broder to the south. These deposits are scattered over the region as isolated ridges and mounts.

The pitted or sinkhole pattern from airphoto helps to delineate this deposit easily. However, in a few areas the sinkholes are not very well developed but the indication of sinks still exist.

Sinkholes create a rolling topography in this land form region. Most of the surface waters are collected and drained through the sinks. Surface gullies usually occur along the perimeter.

The soil in this land form is developed under a thin layer of loess (about 40 inches (102 cm) in thickness) overlying a thin layer of Wisconsinan drift and then the limestone bedrock. The soil profiles are essentially the same as those in the thin Illinoian drift over limestone area except that the drift between the loess strata and the limestone bedrock is different in geological age and the texture is slightly coarser in the Wisconsinan drift than the Illinoian drift. More sandy and gravelly soils are found in the profile in the topographic low sinkhole areas.

A well record taken at NE$\frac{1}{4}$ of SW$\frac{1}{4}$ of Sec. 33, T.15N., R.3W. indicated that limestone is encountered below eight feet (2.4 m) of clay (14). A large limestone quarry in Harrodsburg limestone is operating on one of the hills at SW$\frac{1}{4}$ of Sec. 13, T.14N., R.3W. by Martin Marietta Aggregates Control Division. Two small abandoned guarries were observed from airphotos on one of the ridges located in Sec. 2 , T.13N., R.3W.

The problems in this area mainly are associated with the sinkhole formation. Drainage of the clogged sinkholes, high moisture contain during wet seasons, cut and fill in different

material and poor supporting characteristics of the soil may confront the designer.

7. Eskers

Only two eskers are recognized in Putnam County. The most outstanding one is about two miles (3.2 km) in length located near Clear Creek in sections 23, 27 and 34 of T.15N., R.3W. This esker is narrow and straight about 10 to 20 feet (3 to 6 m) higher than the surrounding till plain. The other one is located near Big Raccoon Creek at the vicinity of junction of sections 22, 23 and 27 in T.16N., R.5W. This ridge is less than ten feet (3 m) above its surrounding land and less than half mile (800 m) in length. The border with the adjacent till on the north is not sharp as those of the esker to the east.

Two gravel pits were located on the west esker but five pits were operated in the esker to the east in 1939, as recorded in the 1940 airphotos.

The soils developed on eskers vary considerably. Due to the thin loess mantle and the degree of erosion, the A-horizon varies greatly in both texture and in thickness. Soil classified as loam, clay loam, silt loam and silty clay loam may be found. In areas of severe erosion the surface soil may be entirely gone and the subsoil exposed. The B-horizon varies from clay loam to clay with varying amounts of sand and gravel for different deposits. The amount of sand and gravel increases very rapidly with depth. Clean stratified sands and gravels are found in the parent material zone. This stratified coarse material disappears

rapidly from the base of the esker and merges with the glacial till in the surrounding areas.

No engineering problems are expected in this deposit. In fact it is a good source of construction material.

Fluvial Deposited Materials

About one fifth of Putnam County is covered by fluvial deposited materials. Four different land forms created by the action of water, namely outwash plain, terrace, lacustrine plain and alluvial plain are discussed as follows:

1. Outwash Plains

About seven square miles (18 sq km) of outwash plains exist within Putnam County. The outwash plains were deposited during the period of glaciation and are confined in the southwest quarter of the county. The largest area is located south of Manhattan between Deer Creek and Eel River. Smaller ones are scattered along the tributaries of Mill Creek and Troys Creek.

The topography of the outwash plain varies from undulating to highly dissected. The airphoto interpretation element such as infiltration basins, current scars and the flatness of the plains which are outstanding characteristics of younger outwash plains are entirely absent. Due to the older age of the deposit and the influence of the underlying bedrock surface drainage is well developed and erosion has carved the one nearly level plain into a highly dissected area. Forestry is the major agricultural land use in the region of steep slopes.

Soils developed in this area are derived from a loess blanket with a thickness ranging from less than 18 inches (45 cm) to about 60 inches (152 cm) and the underlying sandy outwash material. The outwash deposits vary in depth from a few feet (1 m) to over 100 feet (30 m) and the composition is mainly sands with a small amount of gravels.

The soil profile consist of a surface material that varies from a sandy loam to a silt loam. The subsurface soils are somewhat more clayey in texture, ranging from loam to silty clay. The subsoil is a less plastic sandy loam or silt loam. The stratified waterlaid sands and gravels are found from about 3 to 6 feet (.9 to 1.9 m) below the surface. The depth of leaching of this soil is about 15 feet (4.6 m).

Boring data along I-70 varified the profile accurately. At site No. 7, sandy loam (A-4 soil) is found immediately below the topsoil. At sites Nos. 17 and 18, 6 to 8 feet (1.8 to 2.4 m) of silt loan (A-6 soil) over sandy loam and then sand (A-2-4) further down. Sites Nos. from 24 to 30 are within this region where sandy loam were found beneath the topsoil. The sandy loam is composed of 57% of sand, 24% of silt and 19% of clay. Sand (A-2-4 soil) is found further down in the profile in which 2% of gravel, 84% of sand, 4% of silt and 10% of clay were recorded. Bedrock was encountered in this region with a depth various from 8 to 46 feet (2.4 to 14 m) (11).

Well record on the NW$\frac{1}{4}$ of NE$\frac{1}{4}$ of Sec. 25 T.13N., R.5.W. indicated that 18 feet (5.5 m) of sand underly the 8 feet (2.4 m) of surface soil. Another well located at the SE$\frac{1}{4}$ of SW$\frac{1}{4}$ of the

same section shows that 32 feet (9.8 m) of sand overlain by 15 feet (4.6 m) of surface soil (14).

There should be limited engineering problems in this area except the cut and fill requirements.

2. <u>Terrace</u>

Three types of terraces occur in Putnam County. They are the coarse textured terrace, medium textured terrace and the slack water terrace. The detail of each is discussed as follows:

(a) <u>Coarse Textured Terraces</u>

Most of the terraces in Putnam County are classified in this category. They are scattered along the main channels of Big Raccoon Creek, Little Walnut Creek, Big Walnut Creek and Deer Creek.

All of the terraces are low terraces. They are about 10 to 20 feet (3 to 6 m) higher than the bottom land adjacent to them. Infiltration basins and current scars appear only sparingly and the once nearly level terraces have been dissected by surface erosion in many places. However, the break between the upland and the terraces is clearly defined.

The soil profile of the granular terrace consists of a silt loam to silty clay loam topsoil underlain by a silty clay loam to clay and then a gravelly to a sandy clay subsoil. A clayey sand and gravel layer is encountered before the calcareous sand and gravel parent material.

Boring site No. 31 along I-70 is located on a terrace. A 7.5 feet (2.3 m) of silt loam (A-6 soil) is found below the topsoil. This soil is composed of 44% snad and 56% silt. A 4 feet (1.22 m) sandy loam (A-2-4 soil) which consists of 1% of gravel, 76% of sand, 8% of silt and 16% of clay underlies the subsurface soil. Sandy clay (A-6 soil) is found further down the profile. The sandy clay layer has 3% of gravel, 62% of sand, 6% of silt and 32% of clay in its composition. The thick silt loam layer on this site may be attributed to a local factor as the terrace is situated in such a position that wind-blown silt and fine sand from the alluvial plain to the north-west are likely to be deposited on this area.

In general few engineering problems are expected in this land form.

(b) Medium Textured Terraces

The medium textured terrace are confined to the Mill Creek drainage way on the southeastern corner of the county. These terraces are extremely flat and are slightly higher (less than 10 feet (3 m) than the adjacent flood plain. Infiltration basins occur occasionally, but current scars are absent in these deposits. Surface drainage is not very well developed and surface channels are widely spaced.

The soils of the medium textured terraces are developed on stratified silt and sand with small amounts of fine gravel below 42 inches (107 cm). The surface soils varies from a silt loam on the high to a silty clay at the low. The subsoil on the slightly high position is graded from a silty clay loam toward

a sandy loam before stratified material is reached. At the slightly low topography the subsoil is mainly silty clay or clay. The parent material is composed mainly of stratified silt and sand with some sandy clay loam and fine gravel layers occasionally.

Since the deposit is only slightly higher than the adjacent flood plain, high water table, poor drainage condition and ponding during high water are problems.

(c) Slack Water Terraces

Two small areas located along Mill Creek at the southeastern corner of the county may be classified as slack water terraces.

The slack water terraces are extremely flat and only slightly higher than the adjacent flood plain. The topographic break between the flood plain and this terrace deposit is inconspicuous. Infiltration basins and current scars are missing in these terraces. Surface drainage is poorly developed in this area.

The soils of the slack water terraces are developed from stratified silt loam, silty clay loam, silty clay and clay. The soil profile on this deposit consists of a silt loam to silty clay topsoil, a silty clay loam to clay subsoil and the stratified silt loam, silty clay loam to clay parent materials. Some fine sand may be found deep in the profile.

The major problems associated with this area are the high water table and occasional overflow.

3. Lacustrine Plains

Several square miles (about 10 sq. km) on the southeastern corner of Putnam County are mapped as lacustrine plains. The lacustrine plain is part of glacial Lake Quincy extended into Putnam County along the course of Mill Creek from Owen County to the south.

The topography of the lacustrine plain is a nearly level plain broken only by widely spaced drainage channels. Except in the gully or channel areas, the plains are extensively farmed. White fringes around the gullies reveal the presence of silt covering material which overlies the fine textured lacustrine deposits.

Soils of these lacustrine plains are developed from a blanket of loess material, ranging from 10 to 40 inches (25 to 100 cm) in thickness and the underlying stratified lacustrine deposit. The topsoil of this area varies from a silt loam to a silty clay loam. The subsurface soil is silty clay to clay in texture. A clay loam layer may be encountered before reaching the stratified parent material. The texture of the stratified lacustrine deposit varies from place to place. Clay, clay loam, silt, silty clay and fine sandy loam are the possible material of these deposits.

Because of the poorly drained situation in some areas, frost heave, settlement and weak supporting power of the soils are the major problems in this deposit.

4. Alluvial Plains or Flood Plains

All drainage channels in Putnam County posssess recent alluvial plains or flood plains. However, the extent of mapping

of these plains was determined by the scale of the engineering soils map. The larger alluvial plains are associated with Mill Creek, Raccoon Creek, Big Walnut Creek, Little Walnut Creek and Eel River. The widest alluvial plain (about one mile (1.6 km) in width) is located along Eel River at the southwestern corner of the county. The wide alluvial plains along Big Raccoon Creek, Little Walnut Creek, Big Walnut Creek and Deer Creek are significantly narrow in a number of places where the creeks cut through resistant rocks.

Most of the alluvial plains have flat to nearly level surfaces. Natural levees are developed along a portion of the large streams. Special features such as current markings, meandering stream channels, oxbows and abondoned channel are plentiful along the major streams in Putnam County. Most of these land forms are too small to show on the map.

The texture of the alluvial deposits varies greatly both horizontally and vertically from one place to the other. The texture of the deposit depends mainly on the nature of the drainage basin. Coarse textured deposits are found adjacent to the main channel especially on the natural levees, loamy textured soil occurs near the main channel while silt loam becomes more prominent toward the valley walls. Silty clay loam soils are concentrated in old swales, depressions near the valley wall and most of the extremely flat Mill Creek along the southeastern corner of the county. Sandstone and shale fragments may be found in the deposit along Troys Creek at the southwestern corner of the county.

The variability of the soil profile is shown in the soil profile. The surface soil ranges from fine sandy loam to loam, silt loam and silty clay loam. The subsurvace soils are also extremely variable. Sandy loam, silty clay loam, silty clay or clay may be encountered. The material may become more corase with increases of depth. Stratified sand and gravel may be found in areas close to the main channels, whereas in other areas stratified loam, fine sandy loam, silt loam and silt are most common.

The alluvial soil actually has little profile development other than the constant accumulation of washin materials. The granular texture of the deposit is illustrated by the gravel pit located in the flood plain of Eel River between sections 28 and 33 of T.13W., R.5W.

Boring data along I-70 also reveal the varibility of the texture of the alluvial deposits. At site No. 4 a 5.5 feet (1.68 m) of sandy loam (A-4 soil) is found below the six inches (15 cm) of surface soil. Before the sand (A-2-4 soil) is reached a two feet (50 cm) silty clay (A-7-6 soil) is encountered in the profile (10). More clayey deposits are shown at site No. 5 which is closer to the valley wall to the east. A 5 feet (1.5 m) clay loam (A-4 soil) is found below one foot (30 cm) of topsoil and overlain a two foot (50 cm) layer of sandy loam (A-4 soil) before reaching the stiff silty clay (A-7-6 soil).

Sites Nos. 19 to 23 are located in the flood plain of Eel River. Site No. 20 is close to the main channel where sand is found from the surface down. There were 32% of gravel 63% of sand, 4% of silt and 1% of clay in the sample taken 10 to 12 feet

(3 to 3.7 m) from the surface. At the other sites, silty clay, silty clay loam, silt loam and loam were encountered. Finer textured deposit is illustrated at site No. 23. The profile consists of one foot (25 cm) of silty clay (A-6 topsoil) then a 5 foot (1.5 m) layer of stiff clay (A-6 soil) and a stiff loam (A-4 soil) which composed of 40% of sand, 41% of silt and 19% of clay.

Borings on the narrow flood plain along the small tributaries indicated a layer of sandy loam (A-4 to A-2-4 soil) were found under the clay loam, silty clay loam or silty clay subsurface soil as illustrated at sites Nos. 67, 105, 111 and 112.

More clayey deposits were found on the alluvial plain along Mill Creek drainage basin. At site No. 130 the profile shows that following the 0.8 foot (20 cm) of silty clay (A-6 surface soil) is a 1.2 foot (30 cm) layer of clay (A-6) and 2.5 feet (64 cm) of silty clay (A-7-6 soil) before the sandy loam (A-6) layer is reached. Site No. 151 located near the edge of Mill Creek flood plain shows a clayey soil (A-6 to A-7-6) from the surface down to a depth of 10 feet (3 m) (13).

A few well logs located on flood plains reveal the sandy texture of the large flood plains. Along Big Walnut Creek at NW$\frac{1}{4}$ of SW$\frac{1}{4}$ of Sec. 29 T.15N., R.3W. there were 8 feet (2.4 m) of clay overlying 10 feet (3 m) of gravel with clay following by a 3 foot (.9 m) hard pan and then sand and gravel. At NE$\frac{1}{4}$ of Sec. 17 T.14N., R.4W. a 37 foot (11.3 m) sand and gravel overlying limestone bedrock is recorded. At NW$\frac{1}{4}$ Sec. 20 T.13N., R.4W. along the flood plain of Deer Creek well records show that sand and gravel layer (15 to 19 feet - 4.6 to 5.8 m) is overlain

by six feet (1.8 m) of sandy clay and underlying by 3.5 to 9 feet (1.07 to 2.75 m) of gravel with clay before the limestone bedrock is reached. The large flood plain of Eel River at Sections 20 and 29 shows that the sand and gravel layer over the limestone bedrock varies from 44 to 62 feet (13.4 to 18.9 m) (14).

Flooding is the major problem in this area. Subgrade support is poor during wet seasons especially at the depressions close to the valley walls and along Mill Creek and its tributaries.

Eolian Deposited Material

Extensive eolian deposits occur in Putnam County. They are subdivided into two groups namely: loess mantle deposits and sand dune deposits.

1. Loess Deposit

Nearly the whole county is covered by a thin mantle of loess. As mentioned previously, the mantle varies in depth from 10 to 60 inches (25 to 150 cm) or more with occasional depth to 72 inches (183 cm). Since the blanket is rather uniform and comparatively thin, only the top part of the soil profile is subject to its influence. The discussion of this loess mantle in not treated separately but included with the other landforms previously discussed.

2. Sand Dune

The sand dune deposits are very limited in Putnam County. They are confined to the bluffs of the Big Walnut Creek and Mill Creek only. The largest sand dune area is located in Section 17 T.13N., R.2W. on the west bank of Mill Creek and southeast of the large flood plain of its tributary.

The sand dunes in Putnam County are irregular in shape and exhibit softly rolling to hilly topography. Hummocky landscape may appear in places.

Soils developed in this area are derived from windblown sands and in places mixed with windblown silts. The deposit is not thick, with an average depth of four feet (1.2 m) or less and seldom over lo feet (3 m). The surface soil varies from loam to sandy loam or fine sand. If silt is in high portion, a silty clay loam subsurface soil may be found. Otherwise, it is underlain by a sandy clay loam subsurface soil and followed by a sandy loam before reaching the windblown fine sand deposit. Where the deposit is shallow a silt loam soil may be encountered before reaching the clay loam glacial drift.

Little or no problem other than stabilization and compaction are expected in this area. However, if deep cuts are required the characteristic of the underlying drift should be taken into account.

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APPENDIX A

I-70 Boring Data in Putnam County

The soil test data tabulated below was obtained from consultants' reports prepared for the Indiana State Highway Commission. The location of the site is shown on the attached engineering soils map. Considerable additional data is contained in the consultants' reports.

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent				L.L.	P.L.	P.I.	S.L.
						Gravel	Sand	Silt	Clay				
1	1598+75	42 Lt	0.5-2	A-7-6(19)	Si. Cl.	1	9	55	35	55	26	29	19
2	1617+75	42 Lt	2-4	A-6(13)	Clay	2	24	43	31	37	14	23	14
3	1621+00	42 Rt	0-2	A-6(9)	Si.Cl.	1	19	50	30	30	18	12	13
4	1634+00	42 Lt	8-9	A-2-4(0)	Sand	16	73	8	3	NP	NP	NP	NP
5	1652+00	42 Lt	8-10	A-7-6(20)	Si.Cl.	0	1	57	42	64	26	38	17
6	1663+80	42 Lt	2-4	A-6(10)	Cl.L.	2	29	44	25	36	20	16	16
7	1673+00	42 Rt	6-8	A-4(3)	Sa.L.	1	53	34	12	NP	NP	NP	NP
8	1679+00	42 Rt	14-16	A-4(3)	Sa.Cl.L.	7	50	23	20	20	14	6	14
9	1686+75	42 Rt	8-10	A-4(3)	Sa.L.	8	50	24	18	20	14	6	14
10	1691+00	42 Rt	2-4	A-2-4(0)	Sa.L.	29	56	10	5	NP	NP	NP	NP
11	1709+00	42 Rt	2-4	A-6(12)	Si.Cl.L.	0	8	65	27	39	20	19	14
12	1712+00	42 Rt	2-4	A-4(1)	Sa.Cl.L.	1	61	16	22	21	16	5	15
13	1724+60	42 Lt	8-10	A-6(12)	Clay	0	18	33	49	34	20	14	15
14	1726+00	42 Rt	6-8	A-6(10)	Clay	0	33	29	38	36	16	20	13
15	1737+00	56 Rt	18-20	A-1-b(0)	Sand	37	57	3	3	NP	NP	NP	NP
16	1740+50	42 Lt	4-6	A-4(2)	Sa.L.	0	59	33	8	NP	NP	NP	NP
			14-16	A-4(8)	Si.L.	0	6	78	16	24	17	7	26
17	1752+00	42 Lt	2-8	A-6(10)	Si.L.	0	12	70	18	34	18	16	18
			17-42	A-2-4(0)	Sand	1	79	13	7	NP	NP	NP	NP

Site	Station	Offset (ft.)	Depth (ft.)	Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
18	1755+00	42 Rt	6-8	A-6(2)	Sa.L.	14	50	26	10	34	23	11	16
			32-34	A-6(13)	Clay	0	24	31	45	36	14	22	16
19	1770+00	42 Rt	0.5-2	A-4(8)	Si.Cl.	0	6	64	30	27	17	10	18
20	1775+50	42 Rt	10-12	A-1-b (0)	Sand	32	63	4	1	NP	NP	NP	NP
21	1782+00	42 Rt	4-6	A-6(10)	Si.Cl.L.	0	26	54	20	35	25	14	22
22	1783+00	42 Lt	2-4	A-6(8)	Si.L.	0	32	59	9	26	15	11	23
23	1792+00	42 Rt	6-8	A-4(8)	Loam	0	40	41	19	26	18	8	19
24	1808+00	42 Lt	6-8	A-4(0)	Sa.L.	0	69	20	11	22	16	6	18
			22-24	A-2-4(0)	Sa.L.	9	56	21	4	NP	NP	NP	NP
25	1812+50	42 Lt	8-10	A-2-4(0)	Sand	2	84	4	10	NP	NP	NP	NP
			28-30	A-4(4)	Sa.L.	6	52	34	8	16	14	2	14
26	1819+00	42 Lt	10-12	A-4(8)	Silt	0	6	85	9	NP	NP	NP	NP
27	1837+35	CL	2-6	A-2-4(0)	Sand	2	82	--	--	NP	NP	NP	NP
			10-12	A-6(5)	Sa.Cl.L.	11	45	21	23	27	16	11	14
28	1839+90	42 Lt	0-5	A-4(2)	Sa.L.	0	57	24	19	20	14	6	15
29	1852+00	42 Lt	1-4	A-6(9)	Si.Cl.	0	6	62	32	39	26	13	19
30	1855+00	42 Rt	2-4	A-2-4(0)	Sa.L.	0	75	8	17	9	NP	NP	NP
31	100+00	42 L"A"	0.5-8	A-6(7)	Si.L.	0	44	56	0	34	20	14	17
			8-12	A-2-4(0)	Sa.L.	1	75	8	16	23	18	5	18
32	119+00	42 R"A"	3-10	A-4(1)	Sa.Cl.L.	0	64	12	24	25	17	8	16
			15-20	A-3(0)	Sand	0	97	0	3	NP	NP	NP	NP
			45-50	A-6(1)	Sa.Cl.L.	1	67	6	26	29	15	14	12
33	133+00	CL"AR"	0.7-2	A-7-6(17)	Clay	1	38	27	35	56	18	38	26
34	137+30	CL"AL"	4.5-6	A-6(9)	Cl.L.	5	24	46	25	32	19	13	18
35	138+75	CL"AL"	0.2-4	A-7-6(14)	Si.Cl.	1	11	51	38	48	27	21	23
36	143+00	CL"AL"	15-20	A-6(7)	Clay	4	43	22	31	34	18	16	15
37	149+00	CL"AL"	3-4.5	A-6(5)	Sa.Cl.	3	60	6	31	36	20	16	18

Site	Station	Offset (ft.)	Depth (ft.)	Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
38	161+75	CL"AL"	2-6	A-4(3)	Sa.Cl.L.	2	52	25	21	24	18	6	16
39	165+50	CL"AR"	11-17	A-7-6(16)	Clay	0	19	35	46	48	22	26	15
40	190+00	CL"AL"	0-1.5	A-6(6)	Cl.L.	7	40	32	21	30	19	11	17
41	193+00	CL"AL"	21-27	A-4(3)	Sa. Cl.L.	6	52	20	22	23	14	9	14
42	203+50	CL"AL"	16-18	A-2-4(0)	Sa.L.	10	64	13	13	23	16	7	14
43	212+80	CL"AR"	4-6	A-6(8)	Si.Cl.L.	0	19	53	28	32	20	12	18
44	215+00	CL"AR"	17.5-19	A-4(6)	Loam	0	44	43	13	21	19	2	17
45	218+50	CL"AR"	4-8	A-4(2)	Sa.Cl.L.	7	53	18	22	19	16	3	12
46	222+00	15R"AR"	4.5-10	A-7-6(15)	Clay	1	37	29	33	46	17	29	15
47	228+00	CL"AR"	17.5-19	A-6(9)	Clay	1	27	41	31	28	16	12	13
48	232+50	CL"AR"	0.4-2.5	A-4(8)	Si.L.	0	14	67	19	33	23	10	23
49	275+90	42L"A"	0.1-6	A-4(8)	Clay	6	24	35	35	30	21	9	22
50	279+50	42L"A"	2.5-6	A-6(7)	Clay	5	40	21	34	29	15	14	16
51	284+00	42L"A"	2-5	A-6(10)	Clay	3	28	35	34	33	18	15	17
52	293+00	42R"A"	0-1.5	A-4(8)	Clay	9	38	24	29	33	23	10	22
			1.5-4.0	A-7-6(14)	Clay	6	20	29	45	44	21	23	16
53	311+00	42R"A"	16-22	A-7-6(20)	Clay	3	18	5	74	66	25	41	17
54	320+00	42L"A"	6.7-7	A-6(11)	Clay	0	12	41	47	36	19	17	16
55	323+50	42R"A"	1.5-6	A-6(11)	Clay	4	28	25	44	36	19	17	20
56	331+00	42L"A"	0-4	A-4(8)	Clay	0	14	34	52	35	25	10	25
57	349+20	42R"A"	9-10	A-7-6(15)	Clay	2	28	25	45	43	15	28	14
			13-14	A-6(6)	Clay	6	42	24	28	27	13	14	15
58	353+20	42R"A"	1-3	A-4(5)	Cl.L.	6	39	34	21	31	21	10	21
59	367+00	42L"A"	4-5	A-7-6(14)	Si.Cl.	1	8	61	30	44	21	23	19
60	376+00	42R"A"	4-5	A-7-6(18)	Clay	1	25	45	31	51	21	30	18
61	379+00	42L"A"	0-1	A-6(10)	Si.Cl.L.	0	6	69	25	37	23	14	24
			5-6	A-4(6)	Cl.L.	3	45	26	25	32	22	10	17

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
62	397+00	42R"A"	14-15	A-6(11)	Clay	2	23	34	41	36	18	18	16
63	409+50	42R"A"	0-3.5	A-4(8)	Si.Cl.L.	2	23	53	22	32	23	9	21
64	415+50	42R"A"	2-3	A-7-6(16)	Clay	0	10	44	46	50	24	26	21
65	418+00	42L"A"	6-7	A-6(8)	Cl.L.	3	40	30	27	34	16	18	13
66	421+00	42R"A"	6-7	A-7-6(15)	Clay	1	27	34	38	44	18	26	15
67	423+00	42L"A"	11.5-13	A-4(2)	Sa.L.	21	35	28	15	18	13	5	13
			7-9	A-7-6(14)	Clay	2	24	35	39	42	17	25	14
			12-14	A-6(12)	Clay	0	3	42	55	39	18	21	14
68	423+50	42L"A"	8-9	A-6(5)	Loam	7	4	41	8	27	15	12	15
69	428+00	42R"A"	18-19	A-4(8)	Silt	1	4	88	7	NP	NP	NP	NP
70	431+00	42L"A"	5-6.5	A-6(9)	Clay	1	27	41	31	29	15	14	12
71	472+00	42R"A"	1-3	A-6(10)	Si.Cl.	0	5	54	41	39	23	16	20
72	481+00	42L"A"	10-12	A-6(8)	Clay	0	42	24	34	35	17	18	15
73	505+00	42L"A"	5-6	A-6(11)	Si.Cl.	0	4	62	34	38	22	17	17
74	508+00	42R"A"	7-8	A-6(9)	Cl.L.	1	27	44	28	29	15	14	13
75	510+50	42R"A"	3-4	A-4(7)	Cl.L.	3	28	44	25	25	17	8	17
76	522+00	42R"A"	5-6	A-6(8)	Si.Cl.	0	8	58	34	32	21	11	20
77	525+00	42L"A"	5-6	A-6(9)	Si.Cl.	0	2	64	34	34	21	13	16
78	527+00	42R"A"	4-5	A-7-6(20)	Clay	0	10	11	79	81	26	55	10
79	533+00	42R"A"	6.8-7.8	A-4(0)	Sa.Cl.L.	1	62	15	22	22	15	7	16
80	536+00	42L"A"	1-2	A-6(10)	Si.Cl.	0	1	61	38	40	25	15	19
81	545+00	42R"A"	3-4	A-6(9)	Clay	0	19	41	40	32	19	13	15
82	555+00	42R"A"	9-10	A-7-6(13)	Clay	3	31	25	41	44	19	25	12
83	558+00	42 L	9-10	A-7-6(13)	Clay	28	14	20	38	49	22	27	11
84	561+00	42 R	4-5	A-6(8)	Si.Cl.	0	12	56	32	32	21	11	18
85	564+00	42 L	8.5-9.5	A-2-4(0)	Sa.Cl.L.	0	65	13	22	22	18	4	19
86	567+00	42 R	9-10	A-2-4(0)	Sa.L.	17	52	14	17	23	16	7	18

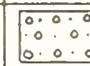
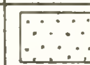
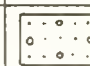
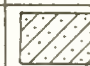
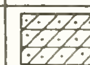
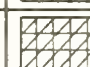
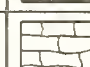
Site	Station	Offset (ft.)	Depth (ft.)	Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
87	588+00	42 R	5-6	A-6(12)	Clay	1	15	48	36	37	18	19	13
88	594+80	42 L	1-2	A-6(10)	Si.Cl.	0	1	55	44	38	24	14	21
89	600+00	42 L	9-10	A-6(8)	Clay	1	37	31	31	32	15	17	13
90	603+00	40 R	1-2	A-7-6(14)	Si.Cl.	0	2	52	46	46	24	22	16
91	609+00	65 L	4-5	A-6(11)	Clay	1	19	47	33	35	17	18	14
92	613+50	42 R	2-3	A-6(11)	Clay	2	22	39	37	35	17	18	14
93	615+00	80 L	4-7	A-6(10)	Clay	2	23	45	30	32	16	16	14
94	616+00	42 R	4-5	A-4(6)	Cl.L.	3	31	41	25	26	16	10	16
95	618+00	84 L	4-5	A-6(10)	Clay	5	28	34	33	38	18	20	10
96	657+26	167 L	3-4	A-7-6(15)	Clay	9	26	30	35	48	18	30	9
97	664+00	42 R	3-5	A-6(10)	Si.Cl.	0	8	52	40	38	24	14	18
98	667+00	41 R	1-2	A-4(8)	Si.Cl.L.	0	10	65	25	29	22	7	23
99	669+14	192 L	7-8	A-4(2)	Sa.L.	15	39	32	14	19	13	6	12
100	677+00	11 R	1-2	A-6(9)	Si.Cl.	0	7	58	35	34	21	13	19
			4-5	A-6(11)	Si.Cl.	0	12	54	34	39	21	18	18
101	681+00	147 L	8-9	A-6(11)	Clay	2	26	42	30	34	16	18	11
102	683+40	126 L	1-2	A-4(8)	Cl.L.	0	26	49	25	29	22	7	19
103	686+00	98 L	5-6	A-6(10)	Si.Cl.	0	7	63	30	37	23	14	19
104	689+00	69 L	4-5	A-6(12)	Clay	1	18	49	32	38	19	19	18
105	691+00	47 R	3-4	A-4(3)	Sa.L.	12	39	35	14	22	15	7	14
106	701+00	52 R	1-2	A-7-6(13)	Si.Cl.	0	5	58	37	42	21	21	16
107	707+00	54 R	7-8	A-6(8)	Cl.L.	2	25	48	25	29	17	12	12
108	725+00	64 R	15-16	A-4(6)	Cl.L.	6	27	39	28	24	14	10	12
109	728+00	42 L	6-7	A-6(7)	Cl.L.	6	31	35	28	28	15	13	14
110	734+08	30 L	2-3	A-4(5)	Loam	0	42	41	17	25	17	8	15
			14-15	A-4(8)	Si.L.	1	14	67	18	24	19	5	20
111	735+00	69 R	4-5	A-2-4(0)	Sa.L.	0	71	21	8	NP	NP	NP	NP

Site	Station	Offset (ft.)	Depth (ft.)	Classifi-cation	Texture	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	L.L.	P.L.	P.I.	S.L.
112	736+00	42 L	2-3	A-4(2)	Sa.L.	0	57	34	9	NP	NP	NP	NP
113	738+00	71 R	1-2	A-4(8)	Si.Cl.L.	1	23	52	24	27	19	8	18
114	741+00	72 R	19-20	A-6(8)	Cl.L.	2	40	29	29	32	15	17	11
115	742+00	42 L	4-7	A-6(8)	Cl.L.	4	29	38	29	30	17	13	12
116	744+00	74 R	4-5	A-7-6(14)	Si.Cl.	0	6	54	40	44	22	22	20
			12-13	A-4(8)	Si.Cl.L.	3	19	51	27	33	23	10	19
117	747+00	75 R	12-13	A-4(6)	Cl.L.	7	29	38	26	23	14	9	11
118	750+00	77 R	1-2	A-7-6(16)	Clay	0	4	49	47	49	24	25	19
119	753+00	78 R	4-5	A-6(8)	Clay	3	29	37	31	30	17	13	13
120	760+00	79 R	3-4	A-6(9)	Cl.L.	1	30	40	29	32	17	15	9
			5-6	A-4(5)	Cl.L.	7	32	38	23	23	14	9	16
121	765+00	42 L	5-6	A-6(10)	Cl.L.	5	20	47	28	33	18	15	16
122	768+00	42 L	1-2	A-7-6(16)	Si.Cl.	0	1	57	42	50	26	24	19
			3-4	A-4(2)	Sa.L.	0	56	31	13	--	--	--	--
			5-6	A-7-6(15)	Clay	1	24	31	44	47	23	24	11
123	792+00	42 L	5-6	A-7-6(13)	Si.Cl.	1	11	53	35	41	19	22	14
124	795+00	42 R	8-9	A-4(8)	Si.Cl.L.	0	5	68	27	29	21	8	19
125	798+00	42 L	1-4	A-7-6(14)	Si.Cl.	0	7	55	38	44	22	22	13
126	851+00	42 L	0.8-2.2	A-6(8)	Si.Cl.	0	12	52	36	35	24	11	17
			8.1-10.0	A-6(12)	Clay	3	28	34	35	38	16	22	12
127	854+00	42 R	3.5-5.0	A-4(6)	Clay	3	31	35	31	30	21	9	13
128	857+00	42 L	0.7-1.5	A-6(8)	Si.Cl.	1	14	50	35	33	22	11	18
129	860+00	42 R	0.0-0.6	A-6(12)	Si.Cl.L.	1	15	57	27	36	17	19	18
			1.7-2.4	A-7-6(16)	Clay	0	10	45	45	48	23	25	17
130	875+00	42 L	0.8-2.0	A-6(12)	Clay	1	23	39	37	40	20	20	13
			4.5-6.0	A-6(1)	Sa.L.	6	57	19	18	27	12	15	13

Site	Station	Offset (ft.)	Depth (ft.)	AASHO Classification	Texture	Percent Gravel	Sand	Silt	Clay	L.L.	P.L.	P.I.	S.L.
131	881+00	42 L	0.8-2.0	A-4(8)	Si.Cl.L.	0	23	51	26	28	18	10	16
			2.4-4.0	A-6(6)	Cl.L.	0	48	28	24	33	15	18	13
132	889+43	42 R	4.2-6.0	A-7-6(10)	Clay	6	24	36	34	42	25	17	16
133	899+00	42 L	2.2-4.0	A-6(10)	Si.Cl.L.	0	20	52	28	35	20	15	14
134	908+00	42 R	2.4-4.0	A-7-6(16)	Si.Cl.	1	8	54	37	47	20	27	16
135	911+00	42 L	7.4-9.0	A-6(8)	Clay	4	28	37	31	28	15	13	14
136	914+00	42 R	1.9-4.0	A-7-6(11)	Clay	1	14	46	39	41	24	17	17
137	917+00	42 L	1.0-1.8	A-7-6(16)	Clay	0	5	46	49	48	21	27	17
138	920+25	42 R	10.5-12.5	A-6(6)	Cl.L.	5	33	33	29	25	14	11	12
139	923+00	42 L	8.0-10.0	A-2-4(0)	Sa.L.	12	54	19	15	16	15	1	11
140	926+00	42 R	8.4-10.0	A-6(6)	Cl.L.	4	37	33	26	26	14	12	13
141	929+00	42 L	5.0-6.4	A-4(3)	Sa.Cl.L.	11	40	25	24	24	16	8	11
			8.2-10.2	A-4(8)	Clay	2	21	42	35	28	24	4	17
			12-14	A-4(8)	Si.Cl.L.	0	17	59	24	29	21	8	21
142	932+00	42 R	0.0-0.6	A-4(8)	Si.Cl.L.	0	11	59	30	32	23	9	20
			15.0-17	A-4(8)	Si.Cl.	1	16	52	31	29	20	9	18
143	935+00	42 L	3-4	A-6(6)	Clay	1	45	22	32	29	14	15	12
			5-7	A-4(5)	Cl.L.	3	35	36	26	24	17	7	15
144	947+00	42 L	0.5-2.0	A-7-6(17)	Clay	1	9	44	46	49	21	28	17
145	953+00	42 L	2.6-4.0	A-7-6(12)	Si.Cl.	0	6	55	39	42	23	19	17
			8.4-10.0	A-4(4)	Cl.L.	11	33	35	21	21	15	6	13
146	957+00	42 R	4.2-6.0	A-4(4)	Loam	0	47	39	14	NP	NP	NP	--
147	961+20	42 L	8.5-10.0	A-2-4(0)	Sa.L.	0	74	17	9	NP	NP	NP	--
148	962+50	42 R	2.4-4.0	A-4(3)	Cl.L.	0	50	27	23	27	18	9	17
149	965+85	42 L	9.8-11.2	A-6(8)	Clay	0	25	41	34	29	18	11	14
150	977+00	42 L	1.4-3.5	A-7-6(17)	Clay	0	7	46	47	49	21	28	15
151	980+00	42 R	2-3	A-6(9)	Clay	0	32	29	39	37	25	12	15
			5.4-7.5	A-7-6(12)	Clay	0	13	39	48	41	22	19	14

APPENDIX B

SOIL CLASSIFICATION AND PROFILE SYMBOLS

Description	Grain Size Distribution				Plastic Index	Symbol
	Gravel % Retained on #10	Sand #10–#200	Silt 0.05–0.005mm	Clay Less than 0.005mm		
Gravel	85–100	0–15	0–10	0–10	NP	
Sandy Gravel	50–85	15–50	0–10	0–10	6 Max.	
Sand	0–15	85–100	0–10	0–10	NP	
Gravelly Sand	20–49	45–85	0–10	0–10	6 Max.	
Sandy Loam	0–19	50–80	0–50	0–20	6 Max.	
Sandy Clay Loam	0–19	50–80	0–30	20–30	10 Max.	
Sandy Clay	0–19	55–70	0–15	30–45	11 Min.	
Loam	0–19	30–50	30–50	0–20	10 Max.	
Silt Loam	0–19	0–50	50–100	0–20	10 Max.	
Silty Clay Loam	0–19	0–30	70–100	20–30	11 Min.	
Silty Clay	0–19	0–15	55–70	30–45	11 Min.	
Clay Loam	0–19	20–50	50–80	20–30	11 Min.	
Clay	0–19	0–55	0–55	30–100	11 Min.	
Peat or Muck						
Limestone						
Sandstone						
Shale						
Stony Fragments						
Organic Matter						
Topsoil						

Classification of Gravelly Soils

85%–100% gravel plus finer material – Gravel
50%–84% gravel plus finer material – Clayey, silty or sandy gravel
20%–49% gravel plus finer material – Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%–19% gravel plus finer material – Use fine classification only

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LEGEND

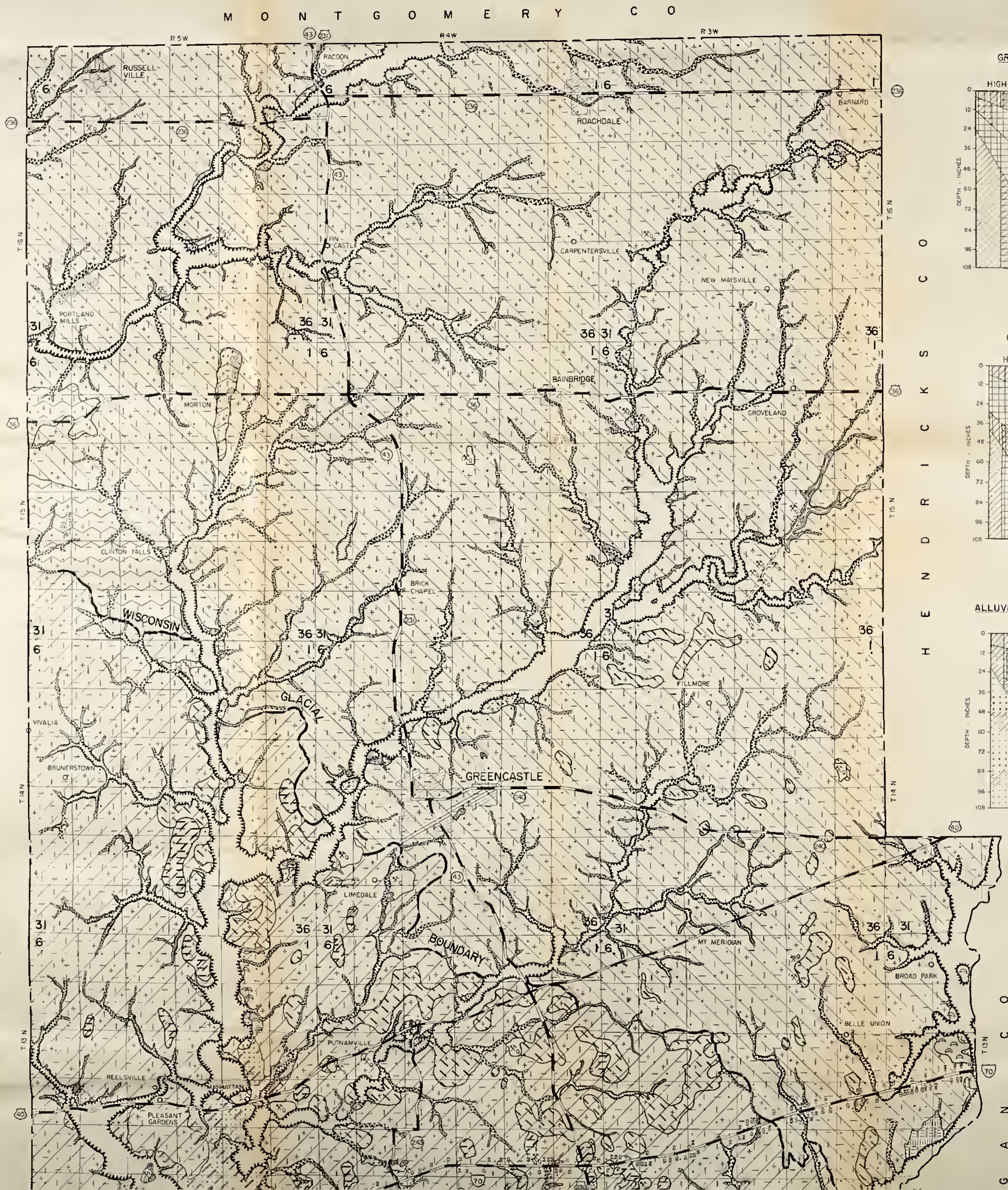
PARENT MATERIALS (GROUPED ACCORDING TO LANDFORM AND ORIGIN)

- GROUND MORAINE, ILLINDIAN
- GROUND MORAINE, WISCONSINAN
- RIDGE MORAINE, WISCONSINAN
- THIN ILLINDIAN DRIFT OVER INTEBEDDED SANDSTONE AND SHALE
- THIN ILLINDIAN DRIFT OVER LIMESTONE
- THIN WISCONSINAN DRIFT OVER LIMESTONE
- ESKER
- SAND DUNE
- ALLUVIAL PLAIN
- OUTWASH PLAIN
- TERRACE
- SLACK WATER TERRACE
- LACUSTRINE PLAIN
- THIN LOESS

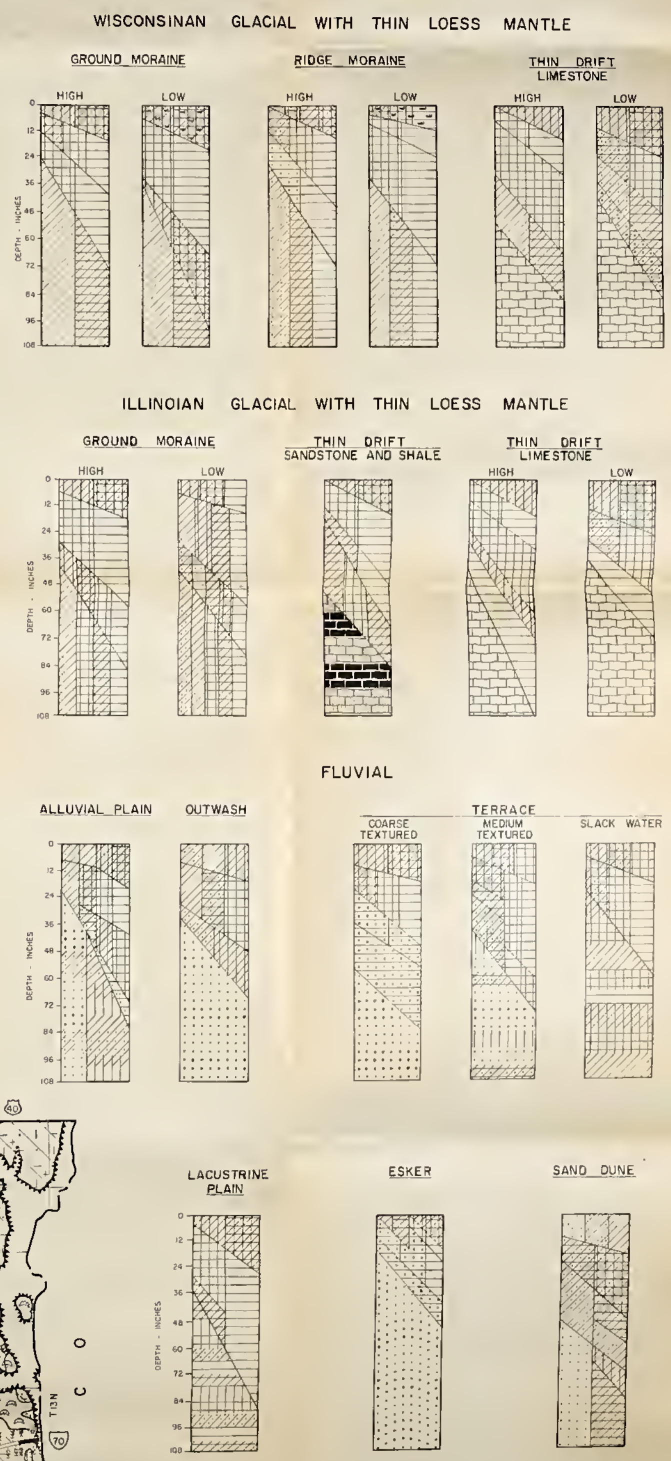
MISCELLANEOUS

- SHALE - SANDSTONE QUARRY
- LIMESTONE QUARRY
- GRAVEL PIT
- LAKE AND POND
- BORING SITES

TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)



GENERAL SOIL PROFILES



OUTWASH PLAIN

TERRACE

SLACK WATER TERRACE

LACUSTRINE PLAIN

THIN LOESS

MISCELLANEOUS

SHALE - SANDSTONE QUARRY

LIMESTONE QUARRY

GRAVEL PIT

LAKE AND POND

BORING SITES

TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

GRAVEL

SAND

SILT

CLAY

TEXTURAL SYMBOLS FOR SOIL PROFILES

SILT

CLAY

LOAM

SANDSTONE

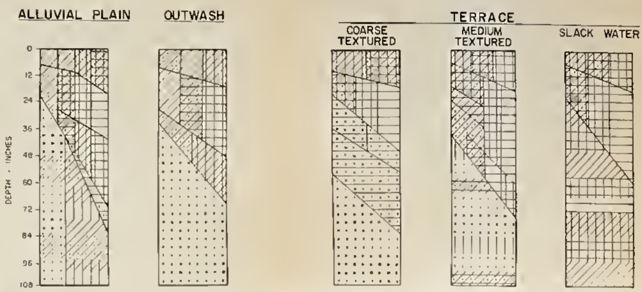
LIMESTONE

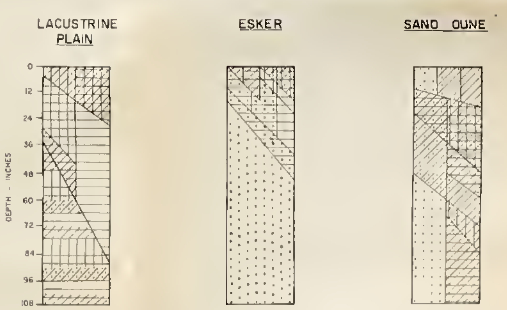
SAND

GRAVEL

ORGANIC MATERIAL

SHALE





ENGINEERING SOILS MAP

PUTNAM COUNTY

INDIANA

PREPARED FROM

1939 AAA AERIAL PHOTOGRAPHS

BY

JOINT HIGHWAY RESEARCH PROJECT

AT

PURDUE UNIVERSITY

1976

SCALE OF MILES

POLYCONIC PROJECTION

PREPARED UNDER THE SUPERVISION OF PT YEH

DRAWN BY J K BUECHLER, L FENO, J. SUTER

COVER DESIGN BY ALDO GIORGINI